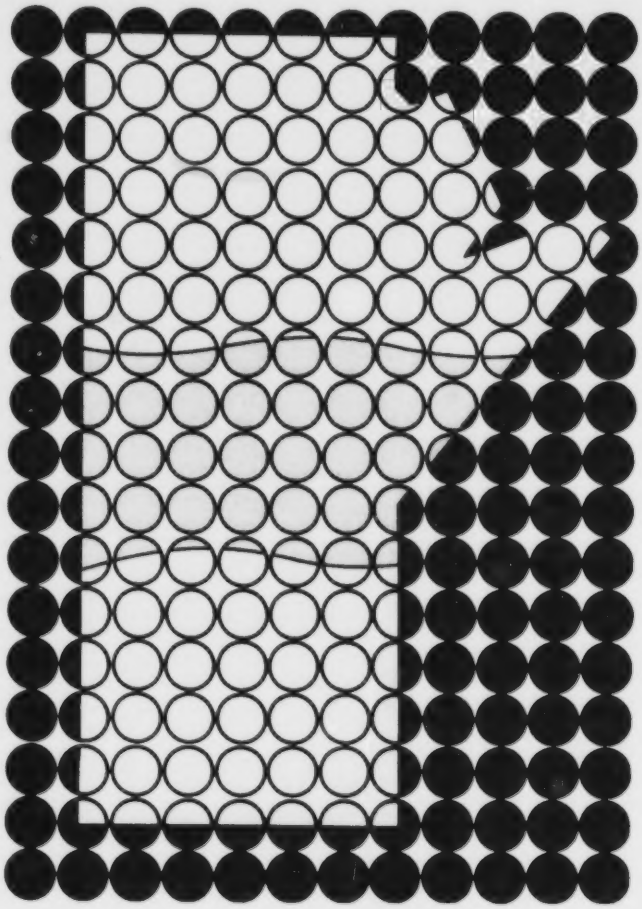

# CANADA-MANITOBA Soil Survey

## Soils of the Plum Lakes Project

Report D81

Government of Canada / Gouvernement du Canada

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MG 1498

SOILS REPORT No. D81 1989

# SOILS OF THE PLUM LAKES PROJECT

by

W. MICHALYNA and E. ST. JACQUES

CANADA-MANITOBA SOIL SURVEY

For

OAK AND PLUM LAKES RESOURCE

MANAGEMENT TASK FORCE

90-03417/

## PREFACE

This interim report and map of the detailed field and laboratory study of the soils of the Plum Lakes Project is one in a new series of such soil survey reports covering special interest areas in southern Manitoba.

The land resource information included in this resurvey covers approximately 15,400 ha of land in the vicinity of Oak Lake. It covers only a fraction of the area covered in the former reconnaissance surveys of Rossburn and Virden areas (Report No. 6). However, the projected more intensive use of the soils for agriculture and the growing competition for other uses of land such as wildlife and recreation in the areas has created a need for more up-to-date, more accurate and more detailed soil information. The increased examination of soils in the field, the use of current aerial photography, the use of improved methods of studying soils in the laboratory and the accumulated knowledge of the properties and uses of soils over the years, have all contributed to the additional information contained in this report.

During the course of the resurvey of the map areas, a considerable volume of site specific soil data was generated that for practical reasons cannot be included in this interim report. These data are currently being input into the Canada Soil Information System (CanSIS) data bank. This computerized system of data management permits automated manipulation and statistical evaluation of large volumes of data for soil characterization and interpretations. These data can be made available on request. In addition, the cartographic file of CanSIS provides a capability to produce derived maps of various kinds. The types of derived maps that can be generated from the basic soil map include the sixteen interpretations that are provided in tabular form in this report as well as a number of single feature maps for such characteristics as drainage, texture of surface deposits, slope, stoniness and distribution of salinity.

A package of interpretive maps and single feature derivative maps can be made available on request to: The Canada-Manitoba Soil Survey, Dept. of Soil Science, Rm. 362, Ellis Bldg., University of Manitoba, Winnipeg R3T 2N2.

The Canada-Manitoba Soil Survey trusts that this report and accompanying map will be of value to all individuals and agencies involved with the use of land within the map area.

## ACKNOWLEDGEMENTS

Grateful acknowledgement is made to the following persons:

R.E. Smith, R.G. Eilers and G.F. Mills for reviewing the manuscript.

J. Griffiths for drafting maps and diagrams.

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Barbara Stupak for inputting the manuscript.

C.A. Aglugub and Diane Sandberg for providing the computer output of interpretation tables and legends.

The field work was conducted by E. St. Jacques and W. Michalyna, and assisted by D. Thomlinson.

## HOW TO USE THIS SOIL REPORT

This soil report contains information on the soils of the area, their origin, formation, classification and potential for dryland agriculture, irrigation, engineering and recreational land uses. The report is presented in four parts: Part 1 provides a general description of the area; Part 2 describes the soil mapping and sampling methodology; Part 3 discusses the classification and morphology of soils and Part 4 is an interpretive section on soils for various uses. The soil map(s) is/are presented on aerial photographic bases.

In order to assist the user in retrieving soil information quickly, the following steps are suggested:

Step 1 Consult the map section. Select the appropriate map sheet(s) and specific area of interest.

Step 2 Note the map unit symbols that occur in the area of interest. Compound symbols have their percentile composition in the numerator. The denominator indicates associated landscape features of erosion, topography, stoniness and salinity, respectively.

Step 3 Consult the "Interpretation of Map Unit Symbols and Identification Legend". Symbols are listed alphabetically, giving soil name, soil texture, drainage and subgroup. The soil name associated with a map delineation is not absolute but provides a judgement that the properties of the majority of the area are associated or approximated within the limits of the designated series.

Step 4 Consult the appropriate tables and corresponding guides in Part 4 for interpretive information of identified soil types.

Step 5 For additional information on individual soils, consult Part 3 where the soils are listed in alphabetical order according to soil name.

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# PART 1

# GENERAL DESCRIPTION OF THE PLUM LAKES PROJECT AREA

## 1.1 LOCATION AND EXTENT

The Plum Lakes study area is located in the Municipality of Sifton in southwest Manitoba within the Townships 7, 8 and 9, Ranges 24 and 25W (Figure 1). It covers an area of approximately 15,400 ha (60 square miles) to the southwest, south, and east of Oak Lake.

## 1.2 PRESENT LAND USE

Present land use of the area is dominantly agriculture and wildlife management, with limited area of recreation on the east side of Oak Lake. Agricultural land use occurs on the periphery of the study area with the dominant enterprise of cow-calf production. Lands on the periphery that are above the long term flood zone provide most of the improved pasture, some cereal and forage production, and natural woodland grazing on upland sandy areas. Natural grazing occurs on the transitional areas that are prone to periodic flooding; mixed grasses and sedges are the dominant species. Areas that are saturated during the spring and early summer are used for native hay production; usually the hay is cut and baled in late summer or early fall depending on accessibility to the areas, weather conditions, or wildlife agreements. Wildlife management is mainly restricted to open water bodies and marsh areas that remain saturated throughout the summer and fall. These areas provide habitat for waterfowl and fur bearing animals such as muskrat and mink. The extent of marsh and open bodies varies with water levels; during drier years when water levels were low, such as 1980 and 1961, the periphery of open shallow water bodies become populated with cattail, bullrush and whitetop. Once established they persist for a number of years even though the water levels may be maintained at some higher level.

## 1.3 PHYSIOGRAPHY

The Plum Lakes Project area occurs within the Antler River-Lake Souris Plain subsection of the Saskatchewan Plain Physiographic division (Figure 2). The area is characterized by level to undulating landscapes with localized areas of hummocky, stabilized dune areas and various wetlands and water bodies of which Oak and Plum Lakes are dominant.

## 1.4 BEDROCK

The bedrock underlying the surface deposits is cretaceous shale of the Riding Mountain Formation (Klassen et al 1970), which occur at a depth of 100 to 120 m below the surface. The Millwood Member (14a) consists of a soft greenish grey bentonitic shale which underlies the surface deposits in the immediate Oak Lake vicinity. The Odanah member (14b) is a hard grey siliceous shale which underlies

the surface deposits on the west and southern portions of the project area (Figure 3). The surface of the Millwood member occurs near or below 366 masl; while the bedrock surface of the Odanah occurs above this elevation.

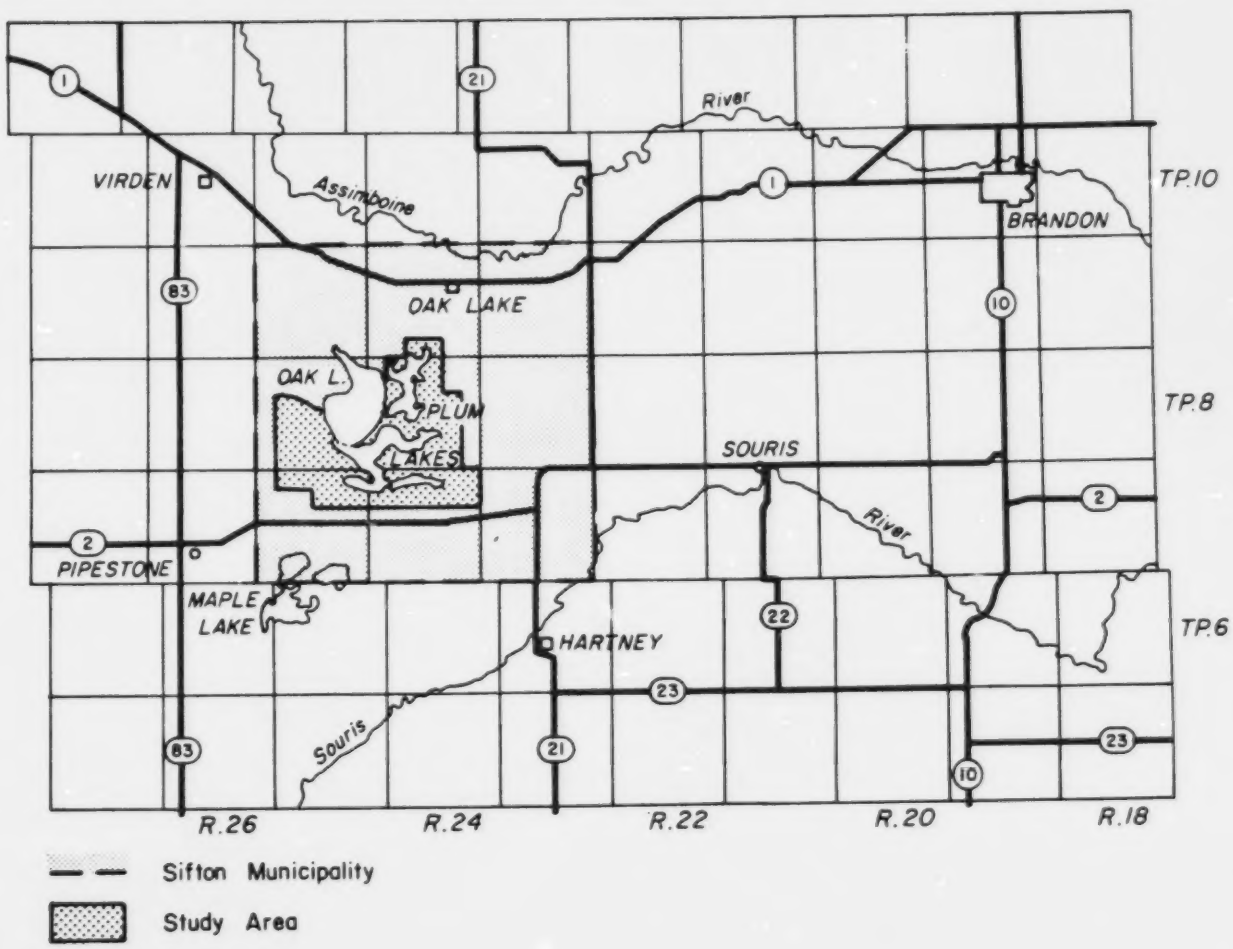
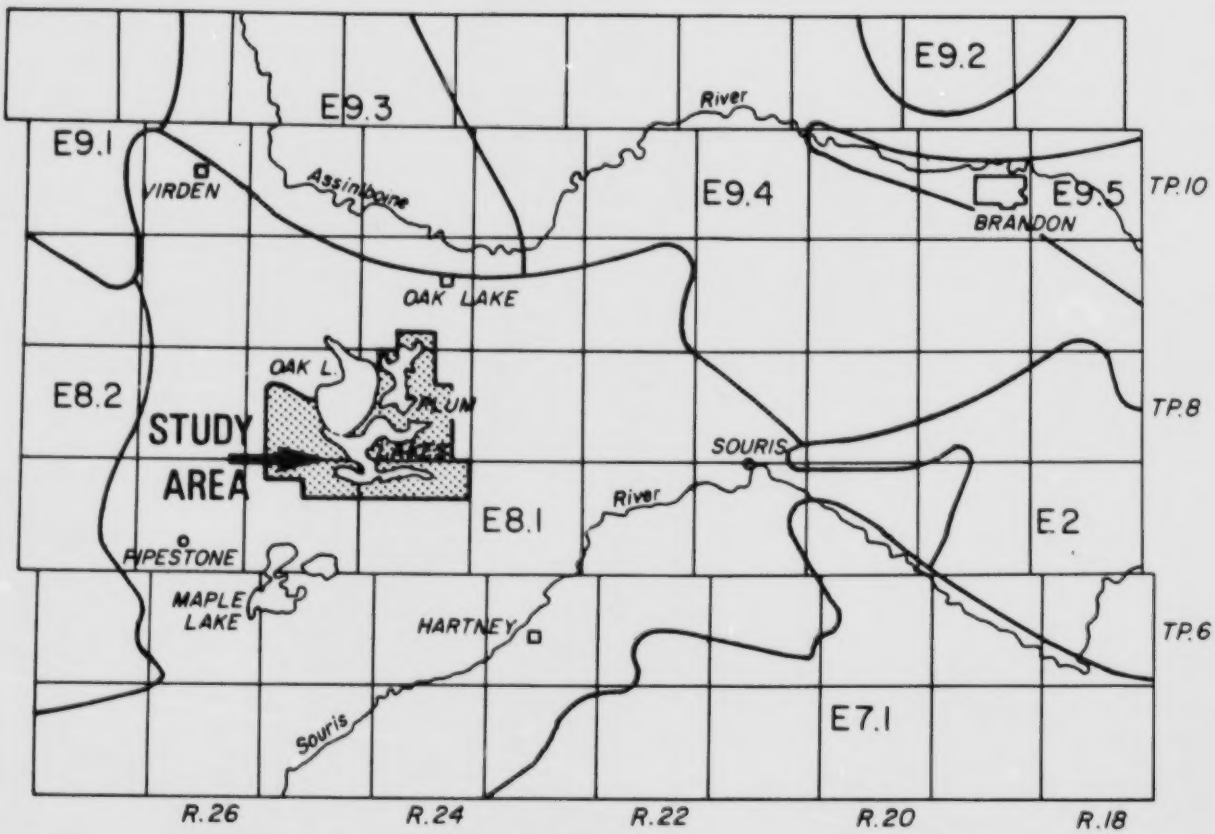
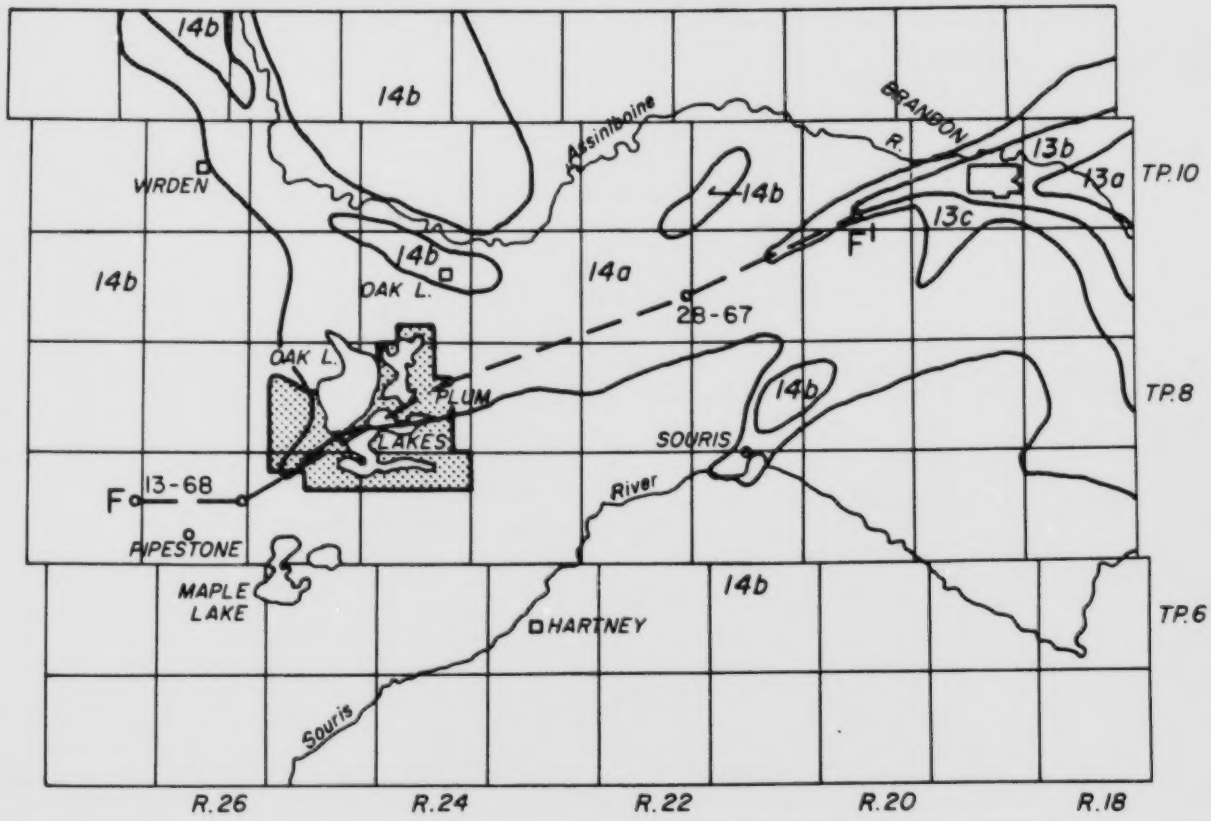



**Figure 1:** Location of Plum Lakes Project in South West Manitoba.




| DIVISION | SECTION | SUBSECTION |
|---|---|---|
| Uplands | E2 Tiger Hills Upland | |
| Plains | E7 Pembina River Plain | .1 Boissevain Plain |
| | E8 Souris River Plain | .1 Antler River - Lake Souris Plain |
| | | .2 Souris Plain |
| | E9 Assiniboine River Plain | .1 Pipestone Plain |
| | | .2 Newdale Plain |
| | | .3 St. Lazare Plain |
| | | .4 Brandon Lakes Plain |
| | | .5 Upper Assiniboine Delta |

**Figure 2:** Physiographic Setting of Plum Lakes Study Area.




*13c Vermillion River Formation – Pembina Member (noncalcareous shale and bentonite)*

*14a Riding Mountain Formation – Millwood Member (greenish grey bentonitic shale)*

*14b Riding Mountain Formation – Odanah Member (hard grey siliceous shale)*

*o— —o Cross-section F – F'*

**Figure 3:** Underlying Bedrock Geology of the Plum Lakes Area and Vicinity.

## 1.5 SURFACE DEPOSITS

The general stratigraphic sequence of the Plum Lake area consists of thin lacustrine and fluvial sediments of dominantly clay and silts, usually less than 2 m thick, overlying sandy lacustrine sediments, that vary in thickness from 10 to 15 m thick. The silt and clay occur as a thin veneer or blanket in level to depressional areas within the extensive Lake Souris sand plain (Figure 5 (Water Resources Branch - Oak Lake Hydrogeology 1986).

Silty sediments with layers of clay underlie the lacustrine sands; the thickness of this unit varies from 10 to 15 m. Lacustrine clay 20 to 30 m thick occurs below the silty unit; the lacustrine clay is underlain by till. Additional stratigraphic information can be derived from: Klassen et al 1970; Ellis and Shafer 1940.

The surface deposits within the upper 1 to 1.5 m is provided in Figure 4 to show the distribution of the clay and silty veneers within the sand plain. Most of the silts or loamy sediments are less than 100 cm (designated 2a in Figure 4) while few areas of silts are thicker than 1 m (2b). Clayey veneers occur in the western part of the project area with the areas of clay sediments of less than 1 m designated as 3a and areas with clay sediments greater than 1 m as 3b.

Areas designated as Marsh (M) may have thin peat layers, generally less than 20 cm thick and a variable shallow depth of silty sediments overlying sandy sediments. Below the surface water (ZZ) areas, the underlying sediments would be similar to the Marsh areas.

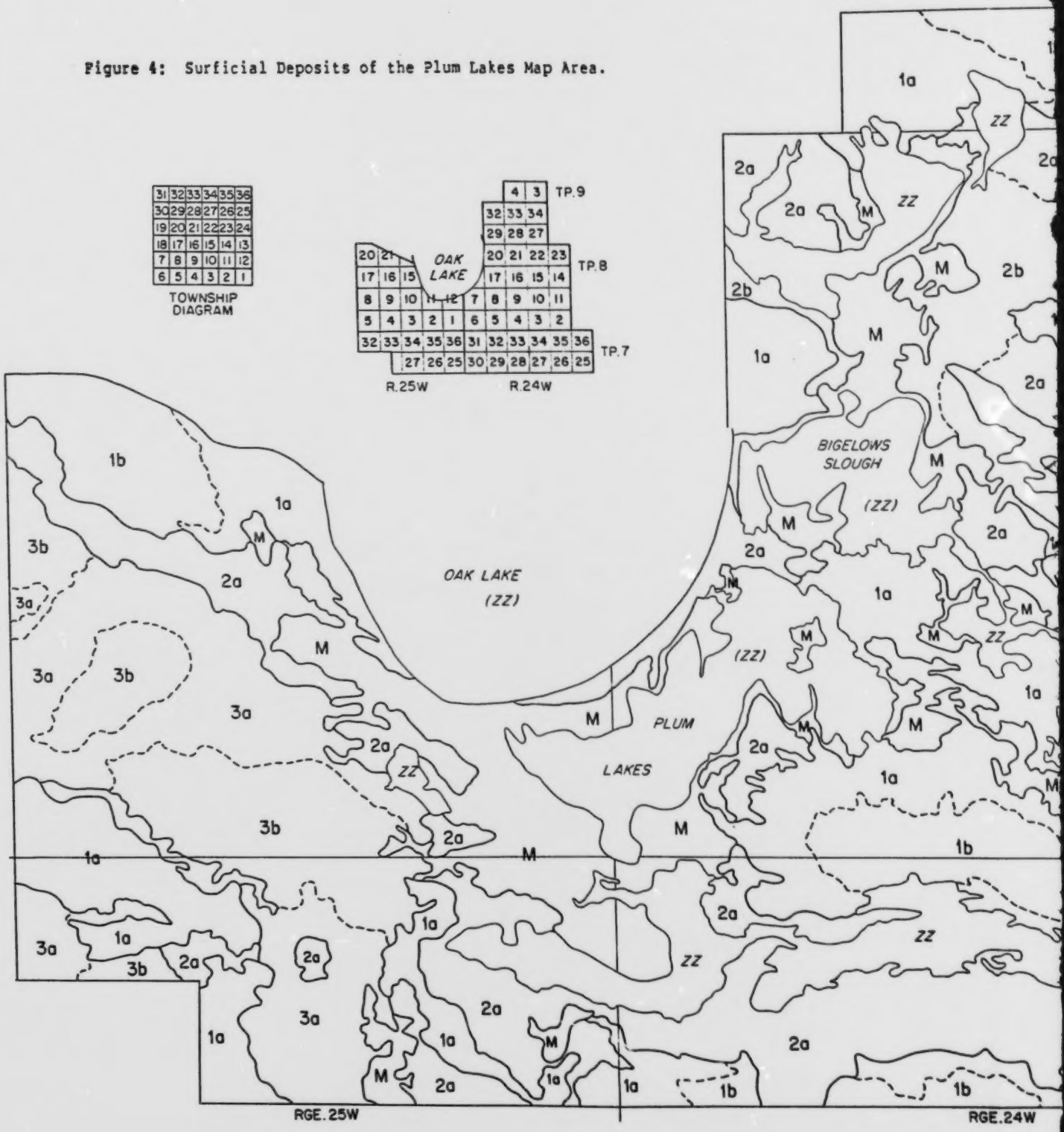
## 1.6 RELIEF

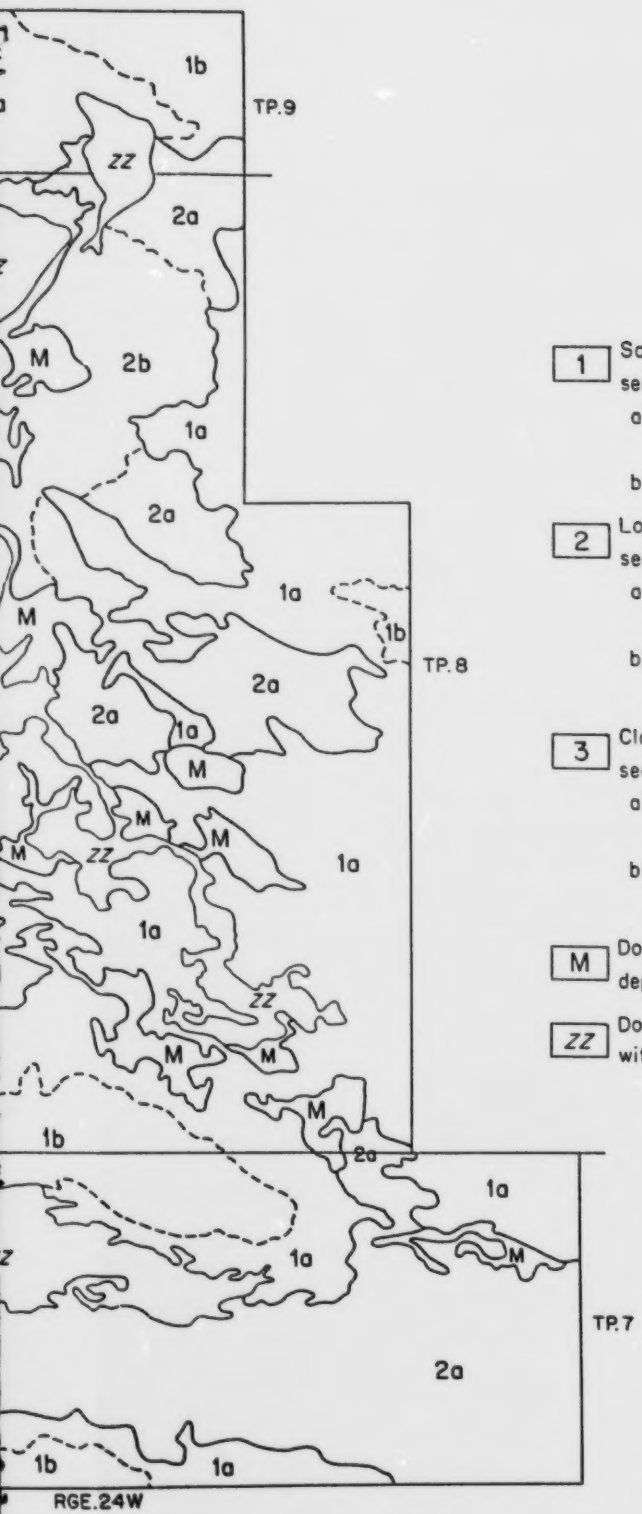
The Plum Lakes area varies in relief from approximately 435 m a.s.l. (1425 ft.) in the periphery of the study area in upland sandy areas to 428 m a.s.l. (1407 ft.), the lowest water levels in marsh and open water bodies in the fall of the year, although in drier years (1961) water levels in open water bodies of the Plum Lakes have been recorded at 428.2 m a.s.l. (1405 ft.). In some years, high water levels in the spring can reach 430 m a.s.l. (1411) and result in flooding of approximately 3/4 of the map area.

Detailed contour maps of the area are being prepared by the Manitoba Mapping and Survey Branch, and should be consulted for precise topographic elevation. However, for the purpose of this report, the soil map unit delineation can provide a general guide to elevation differences. For example, the well to moderately well drained soils mapped as GDC, STU and LYT occur at an elevation above 430.5 m a.s.l. (1412 ft.). Imperfectly drained soils such as CME, HRY, PPT, SOU and WWS commonly occur at elevation of 429.7 to 430.5 m a.s.l. (1410 to 1412 ft.). Poorly drained soils such as CRM, MNV, OKL and PAK occur at elevations of 429 to 429.7 m a.s.l. (1408 to 1410 ft.). Marsh areas are commonly at elevations of 428.5 to 429 m a.s.l. (1406 to 1408 ft.).

The western part of the map area associated with the clay veneer deposits is very flat and has a slope gradient of less than .05 percent toward the Plum Lakes. The area to the south and east of Oak Lake also has relatively level relief, but is influenced by micro hummocky topography characterized by up to 0.6 m change in local relief over short distances of 10 to 15 meters.

Figure 4: Surficial Deposits of the Plum Lakes Map Area.






0 1 MILE

0 1 KILOMETRE

## LEGEND

1 Sandy, deep, weakly to moderately calcareous fluvial and lacustrine sediments with areas of wind-modification (aeolian).

a) relatively smooth, dominantly fluvial and lacustrine with slight wind modification.

b) hummocky, dominantly stabilized aeolian.

2 Loamy, moderately to strongly calcareous fluvial and lacustrine sediments overlying coarser textured lacustrine sediments.

a) shallow (<100 cm.) loamy sediments overlying dominantly sandy sediments.

b) loamy sediments, >100 cm. thick, overlying dominantly sandy sediments.

3 Clayey, moderately to strongly calcareous fluvial and lacustrine sediments overlying coarser textured lacustrine sediments.

a) shallow clayey sediments usually < 100 cm. overlying mainly sandy sediments.

b) clayey sediments, >100 cm. thick, overlying mainly sandy sediments.

M Dominantly marsh areas with thin peat, < 20 cm., and a variable depth of loamy sediments over sand; similar to 2. above.

ZZ Dominantly permament water bodies with minor areas of marsh with underlying sediments; similar to 2. above.

## 1.7 SURFACE AND SUBSURFACE HYDROLOGY

In the Plum Lakes study area, the natural surface drainage is toward the central water bodies from the surrounding higher areas on the east, north, west and south; the only natural outlet is Plum Creek. Oak Lake receives waters from Pipestone Creek and the Pipestone Creek Diversion. The lake levels are maintained at 430 m a.s.l. (1410 ft.) during years of adequate precipitation and runoff; any additional water flows through the control structure at the south end into the Plum Lakes. Surface water flows into Plum Lakes from the southwest through the Bell Creek. Water control dams have been installed at two locations in the Plum Lakes system; one is north of Findlay in SE 31-7-24W and the other northeast of Deleau in S-35-7-24W.

Subsurface hydrology is influenced by the moderately rapid permeability of the sandy sediments. Surface waters in the surrounding sandy areas infiltrate into the near surface groundwater and flows laterally toward the Oak Lake-Plum Lakes area. This is illustrated in Figure 5 where the potentiometric surface near P.T.H. No. 2 south of the lakes is obviously higher than the water levels in the Oak Lake and Plum Lakes. Another local effect is created during the summer, fall and winter when the water levels in Oak Lake may be as much as 1.5 to 2 m above the surrounding soils and water in the Plum Lakes; this condition could cause a local seepage flow (and salt movement) to adjacent soil areas.

High salt contents in the groundwater to the east, south and west of the Plum Lakes was encountered during the soil investigation. The source of the higher salt levels in the near surface groundwater of saline soil area is assumed to be from upward flow of groundwater from deeper strata.

## 1.8 SOIL SALINITY AND TYPE OF SOLUBLE IONS

An overview of the level of salts in the soils is provided in Figure 6 based on EM38 readings of soil conductance, electrical conductivity on soil samples and the profile types recognized during mapping. Non saline areas occur on the edges of the project area where the lands are at higher elevation generally above 432 m a.s.l., and the soil drainage is dominantly well to imperfect, and not subject to flooding. Below this elevation, the soils vary from weakly to strongly saline.

Land areas below an elevation of 431 m a.s.l. are prone to flooding and ponding; Those areas between 429.5 to 431 m a.s.l. have very slow runoff following the flooding period due to the level terrain. Most of the soil water in the root zone is lost through evapotranspiration. The level of salinity in the root zone is affected by the salinity in the groundwater. Salts are moved upward to the soil surface by capillarity and accumulate in the root zone or on the ground surface as this water is lost by evaporation. The higher the salt in the groundwater, the higher the level that could concentrate in the root zone above the water level. A number of electrical conductivity measurements of water in the saturated zone of strongly saline soils were recorded as follows: 16.5 dS/m in section 31-7-24W, 20.0 dS/m in NW 28-8-24W and 17.8 dS/m in SW 15-8-25W.

Strongly saline soils occur in section 27 and 34 in Twp. 7, Rge. 25W in poorly drained areas that have a clayey veneer over sandy sediments;

in localized areas of 27-8-25W on dominantly poorly drained sandy soils and marsh; and in 32-7-24W and 6-8-24W, where poorly drained loamy veneer over sandy sediments occur.

Analysis of the water taken at the saturation zone during soil examination are provided in Table 1. The water samples range in electrical conductivity from 3.8 to 20.0 dS/m. The main anion is sulfate with minor amounts of bicarbonate and chloride. The cations are dominantly magnesium and sodium with usually less amounts of calcium. With the dominant anion of sulfate, it is expected that the soluble calcium would be low due to the precipitation as gypsum ($CaSO_4$).

The sodium cation is considerable and could have an effect on the structure of the soil. The SAR (sodium adsorption ratio) provides a relative measure of the sodium concentration in relation to calcium and magnesium; the SAR values in the soil water from weakly to strongly saline areas range from 3.5 to 13.8. A number of Solonetz profiles were observed in Range 25W on the clay deposits, indicating that the dispersive action of sodium was sufficient to cause the strong columnar structure. A Bn horizon on a Black Solonetz soil within a strongly saline Pipestone clay area had an exchangeable Ca/Na ratio of 1.7, indicative of a dominant sodium effect (exchangeable cations in m.e./100 g were as follows: Ca 9.2, Mg 29.5, Na 5.4, and K 1.0). The cation exchange capacity was 33.1 m.e./100 g and electrical conductivity of the saturated extract was 0.9 dS/m.

## 1.9 CLIMATE

The climate of the Plum Lakes area is cool, subhumid continental characterized by cold winter and warm summer temperatures. The mean annual temperature is approximately 2.0 to 2.5 degrees C; mean January temperature is approximately -18.2 to -19.1 degrees C and mean July temperature is approximately 19.1 to 19.5 degrees C, based on weather data recorded at Virden, Souris and Reston (Table 2). The mean annual precipitation is approximately 455 mm with June being the wettest month with mean monthly precipitation of approximately 72 to 78 mm. Mean frost free period is variable for the area with 103, 118 and 121 days at Souris, Reston and Virden, respectively. Degree days above 5 degrees C is approximately 1700.

## 1.10 ECOREGION

The map area lies within the Grassland transition (Gt3) ecoregion characterized by grassland and aspen-oak areas. The hummocky landscapes at approximately 435 m a.s.l. (1425 ft.) consist of natural areas of mixed grasses and tree species, dominantly aspen and bur oak. The vegetation in the landscapes below the treed areas consist of grasses and shrubs and grade to more water-tolerant grasses, sedges, reeds and cattails in proximity to flood prone and water body areas. Some intermediate areas below 435 m a.s.l. (1425 ft.), and not subject to frequent or periodic flooding, have been cultivated.

Orthic and Rego Blacks are the dominant genetic soil types of well to imperfectly drained landscape positions, while Rego Humic Gleysols are characteristic of the poorly drained positions. More detailed descriptions of the soils in the map

area are contained in Part 3 of this report.

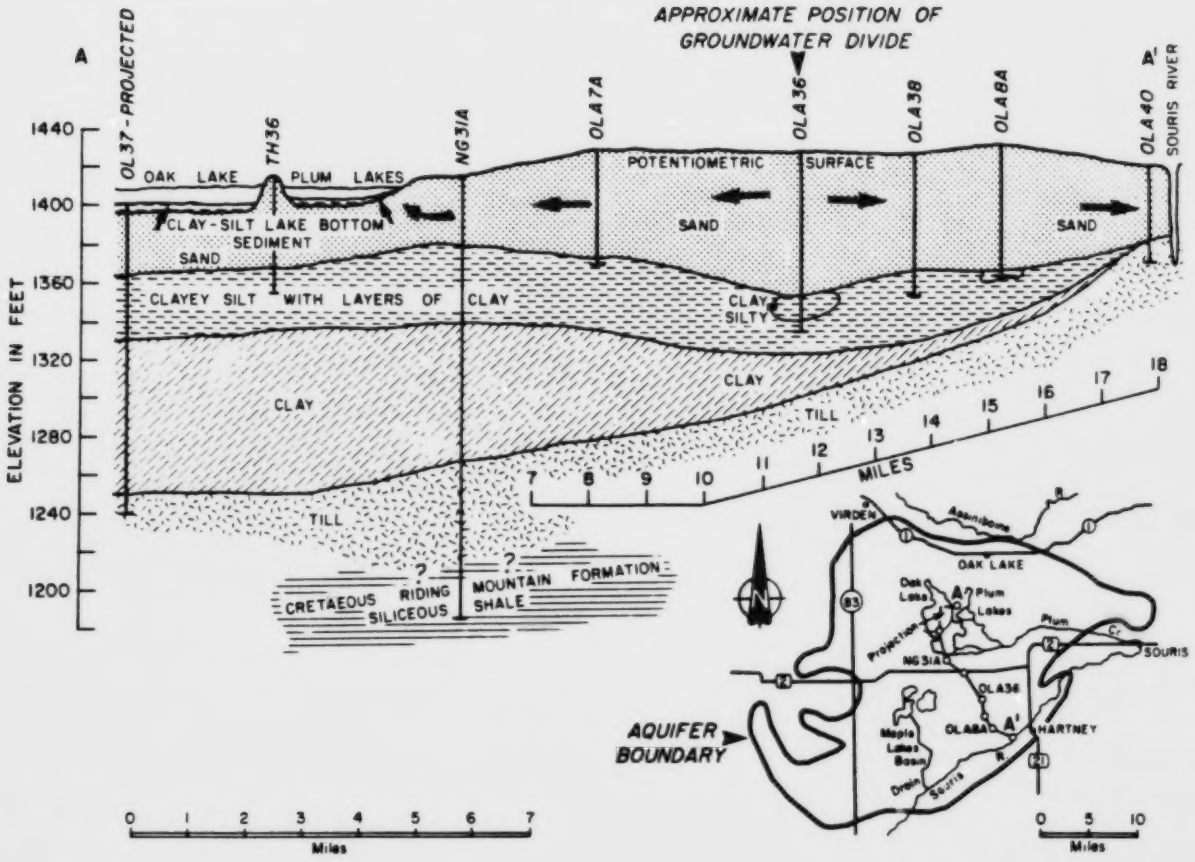
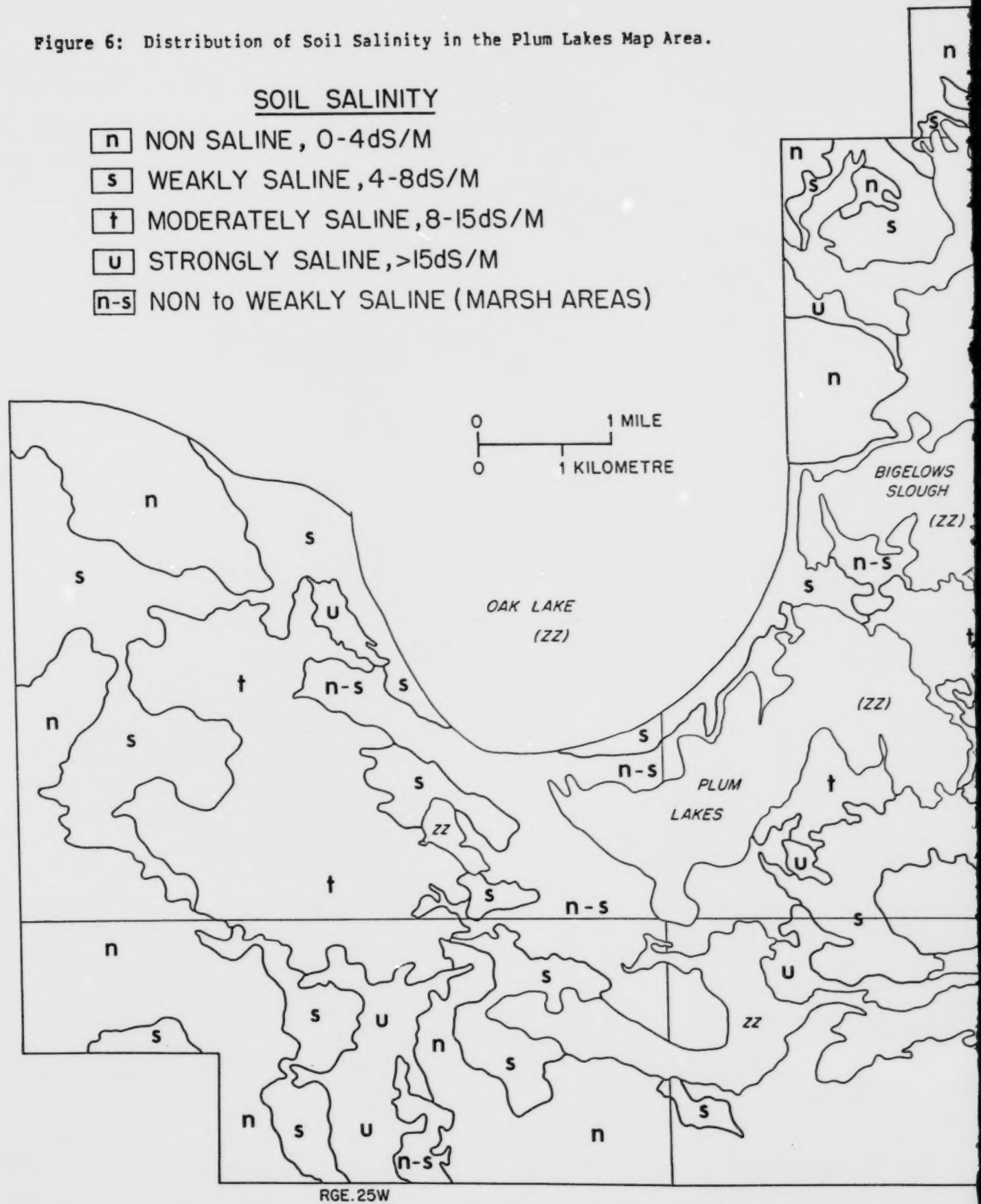



**Figure 5:** Hydraulic Profile and Surface Deposits of the Oak Lake Aquifer (Ref: Water Resources Branch-Oak Lake Hydrogeology 1986).

Figure 6: Distribution of Soil Salinity in the Plum Lakes Map Area.



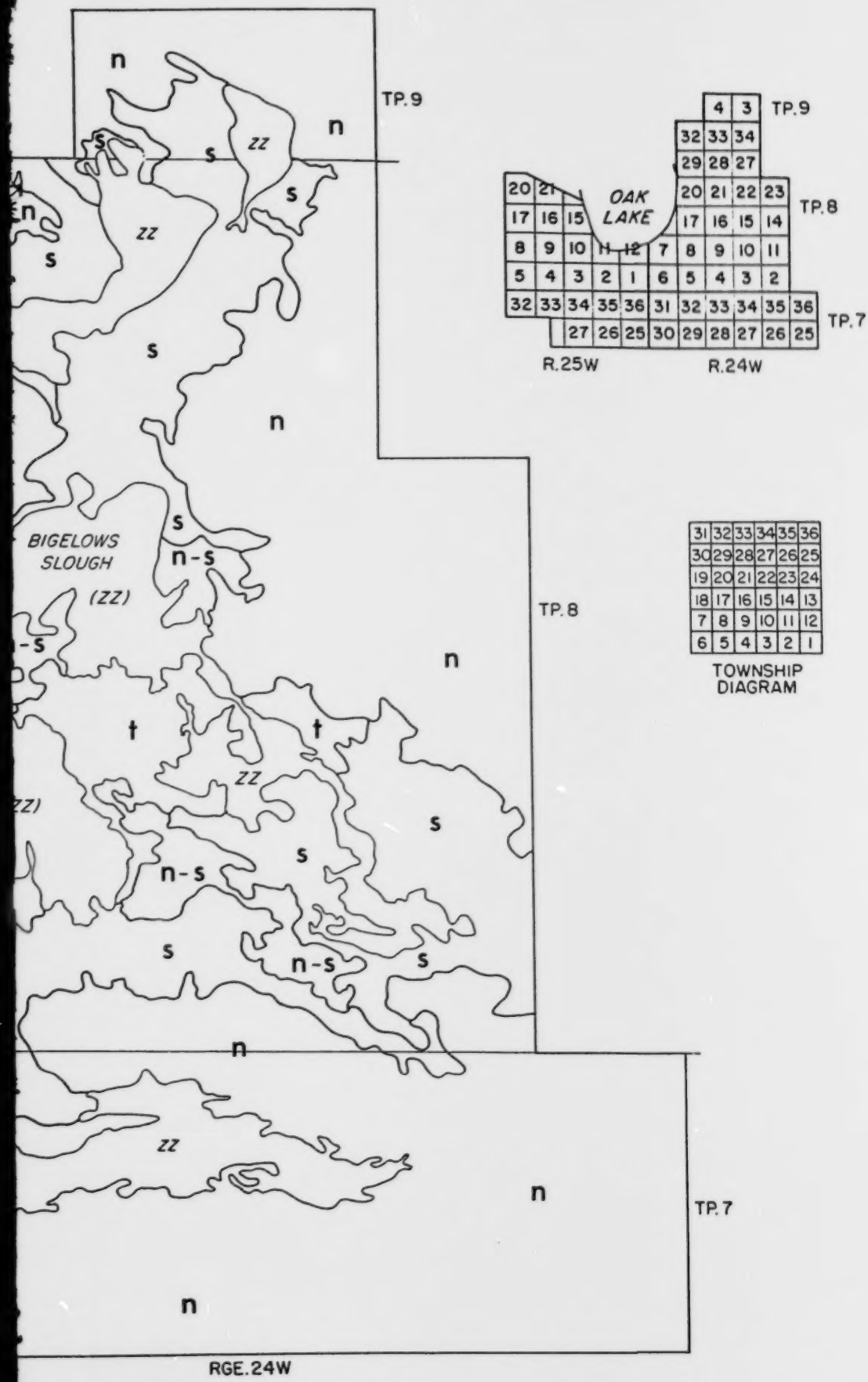

TP. 9
TP. 8
TP. 7
BIGELOWS SLOUGH
(ZZ)
OAK LAKE
R.25W
R.24W
RGE.24W
TOWNSHIP DIAGRAM

Table 1. Soluble Anions and Cations in the Water from the Saturation Zone of Weakly to Strongly Saline Soils

| Location | E.C. dS/m | Soluble Cations and Anions (m.e./l) | | | | | | SAR |
|---|---|---|---|---|---|---|---|---|
| | | Ca | Mg | Na | $HCO_3$ | Cl | $SO_4$ | |
| SW32-07-24W | 3.8 | 6.6 | 24.3 | 17.3 | 12.3 | 2.0 | 38.8 | 4.4 |
| SE09-08-24W | 6.8 | 13.5 | 74.9 | 50.3 | 8.3 | 9.6 | 126.0 | 7.5 |
| SW10-08-24W | 5.5 | 16.7 | 70.0 | 43.4 | 8.7 | 9.2 | 123.4 | 6.6 |
| SW15-08-24W | 4.7 | 7.2 | 78.4 | 54.8 | 7.1 | 9.0 | 133.9 | 8.4 |
| SE28-08-24W | 5.0 | 13.2 | 32.0 | 20.8 | 11.8 | 6.3 | 48.5 | 4.9 |
| NW28-08-24W | 20.0 | 29.5 | 266.5 | 167.0 | 8.5 | 38.2 | 430.4 | 13.8 |
| SW15-08-25W | 17.8 | 32.5 | 192.0 | 117.0 | 11.1 | 22.6 | 318.2 | 11.0 |
| SW15-08-25W* | 5.7 | 12.7 | 32.1 | 16.6 | 2.6 | 2.6 | 60.1 | 3.5 |
| NW27-07-25W** | 16.5 | 41.0 | 152.0 | 130.0 | 2.7 | 6.5 | 308.9 | 13.3 |
| SE32-07-25W** | 5.7 | 17.1 | 28.0 | 41.5 | 2.2 | 1.0 | 89.5 | 8.8 |

* surface water in Marsh Area

** saturation extract on C horizon

Table 2. Climatic Parameters for Virden, Souris and Reston

| Reference | | | Virden | Souris | Reston |
|---|---|---|---|---|---|
| 1 | Mean Annual Temp. °C | | 2.0 | 2.3 | 2.5 |
| | | Jan. | -19.1 | -18.5 | -18.2 |
| 1 | Mean Monthly Summer Temp. °C | June | 16.3 | 16.9 | 16.7 |
| | | July | 19.3 | 19.5 | 19.1 |
| | | Aug. | 17.7 | 17.9 | 17.9 |
| 2 | Mean Annual Precipitation(mm) | | 461.7 | 455.6 | 455.4 |
| | Monthly Precipitation(mm) | Apr. | 29.7 | 32.9 | 28.5 |
| | | May | 45.1 | 46.2 | 49.1 |
| | | June | 72.0 | 78.6 | 77.0 |
| | | July | 67.9 | 68.1 | 70.3 |
| | | Aug. | 66.4 | 66.3 | 73.9 |
| | | Sept. | 49.0 | 45.2 | 49.2 |
| 3 | Last Spring Frost °C Probability | 10%(1 in 10) | June 3 | June 7 | June 9 |
| | | 25%(1 in 4) | May 27 | May 26 | May 28 |
| | | 50%(1 in 2) | May 18 | May 17 | May 22 |
| | | 75%(3 in 4) | May 13 | May 9 | May 8 |
| 3 | First Fall Frost °C Probability | 10%(1 in 10) | Sept. 5 | Aug. 31 | Sept. 4 |
| | | 25%(1 in 4) | Sept. 11 | Sept. 6 | Sept. 9 |
| | | 50%(1 in 2) | Sept. 18 | Sept. 10 | Sept. 14 |
| | | 75%(3 in 4) | Sept. 25 | Sept. 21 | Sept. 17 |
| 3 | Frost Free Period Probability | 10% | 104 | 76 | 97 |
| | (equal to or less than period | 25% | 109 | 94 | 105 |
| | indicated in days) | 50% | 121 | 103 | 118 |
| | | 75% | 130 | 121 | 124 |
| | | 90% | 138 | 126 | 132 |
| 4 | Degree Days Above 5°C | | 1702 | 1697 | - |
| | Degree Days Above 10°C | | 912 | 917 | - |

References Canadian Climatic Normals 1951-1980 (Environment Canada, 1982)


1. Volume 2 Temperatures
2. Volume 3 Precipitation
3. Volume 6 Frost
4. Volume 4 Degree Days

# PART 2

# METHODOLOGY

## 2.1 FIELD INVESTIGATIONS

Soil mapping was conducted in several phases in 1987 due to the complexity and accessibility of the area. During initial correlation and map legend development, it was observed that salinity levels in the soil as well as general profile and stratigraphic characterization would be necessary to compile an adequate soil resource base for the area.

During the summer, soils were examined along selective traverses through the central portion of the area of dominantly poorly drained soils and marsh, using an Argo all-terrain vehicle. Conductance readings using an EM38 instrument were taken at each observation site and the electrical conductivity of the saturated soil zone was read using a portable meter. Samples for salt analysis were taken from selected sites.

During the fall, soil mapping was continued by examining soil profiles to depth of 1 to 1.2 m along selected traverses, through selected sections, along accessible trails and at quarter mile intervals around accessible sections. At each site, the soil and terrain characteristics were recorded and conductance measurements were taken with the EM38 instrument. Samples from selected sites were taken for laboratory measurement of electrical conductivity and soluble ion analysis. Approximately 325 site inspections were made within the 15,500 ha area (or 1 in 47 ha).

Boundaries delineating map units in the survey area were compiled on an aerial photo base at a scale of 1:20,000 (1 cm = 0.21 km).

## 2.2 UNITS OF MAPPING AND SYMBOLOGY

The taxonomic category used to classify soils is the soil series. It is defined as a naturally occurring soil body such that any profile within the body has a similar number and arrangement of horizons, whose color, texture, structure, consistence, thickness, reaction and composition are within a narrowly defined range; they are given a 3-letter code: e.g. SOU - Souris Series. Soil profiles varying only slightly from described series are sometimes encountered. If significant acreages of these soils are encountered, a soil series variant is established. The soil variant is named after the soil series it resembles as well as its differentiating feature; a numeric value is given following the series code, e.g. PPT1 indicates the Pipestone, sandy substrate variant.

The delineation of map units, whether described by one, two or three soil series, is not exact. Map units vary with local topography, drainage, erosion and soil profile properties. The decision to outline and label any given area is based on interpretation and extrapolation of observed soil and landscape features and air photo interpretation. The delineation of soil boundaries serves to separate soils having properties

and conditions which are significant for potential use as field management units.

There are two kinds of map units used in the resurvey of soils in Manitoba. They are simple map units and compound map units.

Simple map units usually contain one dominant soil series, the properties of which vary within narrow limits. The map unit can also contain a small proportion, usually less than 15 percent, of related but unlike soils and phases. The proportion of such undescribed inclusions tends to increase as soil inspection density decreases or where soil variability has no obvious predictable occurrence. Simple map units are normally named after the dominant series.

Compound map units usually contain significant proportions of two or more unlike soil series. These soils are related geographically but cannot be delineated separately because of the intricacy of soil pattern, the cartographic limitations of map scale and survey effort. In many compound map units differences in soils and their related characteristics are strongly contrasting. Dominant, subdominant and minor (if strongly contrasting) soil series are identified, and their percentile proportions within each map delineation is specified. A user must refer to two or more named soil series in the soil legend and soil report to obtain a complete description of a compound map unit.

Additional information is indicated by map unit symbol, such as variations in soil properties or landscape features likely to affect soil management, and includes erosion, slope class, stoniness and salinity. The effect of each one of these four properties or features are indicated according to the degree or magnitude and designated in the following manner:

Erosion

- x - none or only very slight erosion
- 1 - weakly eroded
- 2 - moderately eroded
- 3 - severely eroded
- 0 - overblown

Slope Class

- x - slope classes a-b, i.e. less than 2 percent slope is considered normal for the soil series
- c - 2 to 5 percent slope
- d - 5 to 9 percent slope
- e - 9 to 15 percent slope
- f - 15 to 30 percent slope
- g - 30 to 45 percent slope

Stoniness

- x - non stony
- 1 - slightly stony
- 2 - moderately stony
- 3 - very stony
- 4 - exceedingly stony
- 5 - excessively stony

Salinity

- x - non saline
- s - weakly saline
- t - moderately saline
- u - strongly saline

The convention employed to indicate these features in the map symbol is as follows:

If none of the above properties are observed to be significant, the map unit symbol representing the pure or unaffected soil series is used without modifiers.

If one or more phase features are used, the appropriate letter or number is placed below the soil series

symbol in one of four designated locations in the map unit symbol. The designated order is erosion, slope class, stoniness and finally, salinity. If a particular feature is not observed to be significant, an x is used in its appropriate designated location in the map symbol.

For example, the compound map unit symbols coded:

| 7 | 3 |
|---|---|
| STU | - CRM1 |
| xcxx | xxxs |

indicates that:

:70 percent of the delineated area has properties most appropriately characterized by the Stanton series (STU) with little or minimal erosion (x), on slopes of 2 to 5 percent (c), no stones (x), and minimal salinity (x).

:30 percent has properties of the Cromer, sandy substrate variant, with minimal erosion (x), less than 2 percent slopes (x), no stones (x), and weakly saline (s).

## 2.3 SAMPLING

During the course of field investigations and mapping, soil samples were collected at selected locations for soil characterization and salinity level. At each observation site, notes on the soil properties and landscape were recorded on daily field forms; soil conductance readings were taken with the EM38 instrument and recorded. Selected samples were taken from areas with appreciable salts at depths of 10 to 25 cm and 50 to 60 cm for electrical conductivity determinations and soluble salt analysis.

# PART 3

# SOIL LEGENDS AND DESCRIPTION

## 3.1 SOIL LEGENDS

In similar climatic zones or ecoregions, soils vary considerably because of differences in texture and mineralogical composition of the parent materials and the natural drainage or moisture regime. In the Plum Lakes Project, soil variability is considerable due to the range in texture from sand to clay and in natural drainage from excessive in the sandy uplands to very poor in the lands adjacent to water bodies.

The soil parent material, soil profile type, and related moisture regimes become the dominant features used in classifying and mapping soils. These features can be organized readily to show their relationship in a formal legend as in Table 3, based on a description of the various soil materials and the various soils developed within them. A more concise guide to the soils of the area and the relative properties in terms of brief notations of parent material, soil drainage and subgroup (profile type) is provided in Table 4.

## 3.2 DESCRIPTIONS OF THE SOILS

The soil series of the study area are described in alphabetic order and include a general description of the soil profile, soil texture, parent material characteristics, topography and natural drainage.

Information on the suitability and management of each soil for agriculture, engineering, urban and recreational uses is given in Part 4 of the report.

Table 3. Key to the Soils Mapped in the Plum Lakes Study Area Based on Parent Material, Soil Drainage, and Genetic Soil Type

| | Symbol |
|---|---|
| 1. Soils developed on sandy (LFS FS), weakly to moderately calcareous wind modified lacustrine and fluvial sediments. | |
| a) Rapidly to well drained | |
| i) Grande Clairiere Series (Orthic Regosol) | GDC |
| ii) Stanton Series (Orthic Black) | STU |
| iii) Scarth Series (Rego Black) | SCH |
| b) Imperfectly drained | |
| i) Ralston Series (Gleyed Regosol) | RTO |
| ii) Souris Series (Gleyed Rego Black) | SOU |
| iii) Oak Lake (Rego Humic Gleysol) | OKL |
| 2. Soils developed on coarse loamy (VFS, LVFS, FSL) calcareous, lacustrine and fluvial sediments. | |
| a) Well drained | |
| i) Lyleton Series (Orthic Black) | LYT |
| b) Imperfectly drained | |
| i) Switzer Series (Gleyed Rego Black) | SWZ |
| c) Poorly drained | |
| i) Plum Lake Series (Rego Humic Gleysol) | PAK |
| 3. Soils developed on loamy (VFSL, SiL, L) stratified, moderately to strongly calcareous, lacustrine and fluvial sediments. | |
| a) Moderately well drained | |
| i) Cameron Series (Orthic Black) | CMR |
| b) Imperfectly drained | |
| i) Hartney Series (Gleyed Rego Black) | HRY |
| c) Poorly drained | |
| i) Emblem Series (Rego Humic Gleysol) | EBL |
| 4. Soils developed on fine loamy (SCL, CL, SiCL), moderately to strongly calcareous, lacustrine and fluvial sediments. | |
| a) Imperfectly drained | |
| i) Cranmer Series (Gleyed Rego Black) | CME |
| 5. Soils developed on thin veneer (<90 cm) of loamy, moderately to strongly calcareous lacustrine and fluvial sediments overlying sandy sediments. | |
| a) Imperfectly drained | |
| i) Wawanesa Series (Gleyed Rego Black) | WWS |
| b) Poorly drained | |
| i) Martinville Series (Rego Humic Gleysol) | MNV |
| 6. Soils developed on clay (SiC, C), somewhat stratified, moderately to strongly calcareous lacustrine and fluvial sediments; in this study, sandy sediments may occur within a depth of 1 meter. | |
| a) Imperfectly drained | |
| i) Pipestone Series (Gleyed Rego Black) | PPT |
| ii) Pipestone, sandy substrate | PPTl |
| b) Poorly drained | |
| i) Cromer Series (Rego Humic Gleysol) | CRM |
| ii) Cromer, sandy substrate | CRMl |
| 7. Undifferentiated | |
| a) Very poorly drained | |
| i) Marsh Complex | MHC |
| ii) Open Water | ZZ |

Table 4. Guide to the Soil Series According to Drainage, Subgroup and Parent Material

| Soil Drainage | Sub-group | Parent Materials | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Aeolian | Lacustrine | | | | | |
| | | coarse | coarse | mod. coarse | medium | mod. fine | fine | medium over coarse |
| | | non-weak calc. | mod.-str. calc. | mod.-str. calc. | str. calc. | str. calc. | str. calc. | str. calc. |
| Well | O.BL<br>R.BL | | Stanton (STU)<br>Scarth (SCH) | Lyleton (LYT) | Cameron (CMR) | | | |
| | O.R | Grande-Clairiere (GDC) | | | | | | |
| Imperfect | GLR.BL | | Souris (SOU) | Switzer (SWZ) | Hartney (HRY) | Cranmer (CME) | Pipestone (PPT) | Wawanesa (WWS) |
| | GL.R | Ralston (RTO) | | | | | | |
| Poor | R.HG | | Oak Lake (OKL) | Plum Lake (PAK) | Emblem (EBL) | | Cromer (CRM) | Martinville (MNV) |
| V. Poor | R.G | -- Marsh -- (MHC) | | | | | | |

O.BL = Orthic Black; R.BL = Rego Black; O.R = Orthic Regosol; GLR.BL = Gleyed Rego Black; GL.R = Gleyed Regosol; R.HG = Rego Humic Gleysol; R.G = Rego Gleysol

## Cameron Series (CMR)

The Cameron series is characterized by Orthic Black soil profiles, moderately well to well soil drainage, and parent material of greater than 100 cm of strongly calcareous, loamy lacustrine and fluvial sediments. These soils occur on mid to upper slope topographic positions in very gently sloping to gently undulating landscapes. Surface conditions are usually nonstony; surface runoff is moderately slow. Seasonal water table may be at or below 2 m during the growing season. Permeability is moderate in all horizons. Native vegetation was tall prairie grasses and shrubs. Present land use is agricultural, mainly cereal production. These soils are susceptible to wind erosion if the surface is left unprotected. These soils are non-saline.

A representative soil profile varies from 30 to 45 cm thick, and consists of a black Ap horizon 5 to 15 cm thick, commonly loam in texture; a very dark gray Ah horizon 5 to 12 cm thick; and a dark grayish brown Bm horizon 15 to 20 cm thick. A light gray Cca horizon 7 to 12 cm thick commonly underlies the solum. The parent material is olive yellow.

The Cameron soils are the well drained member of the Cameron Association as described in the Boissevain-Melita Report 1978; the phytomorphic associate medium textured members of the Carroll Association or Souris Association in the South-Western Report, 1940; and Blackearth member of the Carroll loams - Carroll Association in the Rossburn-Virden Report 1956.

## Cranmer Series (CME)

The Cranmer series is characterized by Gleyed Rego Black, (carbonated), soil profiles, imperfect soil drainage, and parent material of greater than 100 cm of strongly calcareous, fine loamy lacustrine and fluvial sediments. These soils occur on mid to lower slope topographic positions in nearly level to undulating landscapes. Surface conditions are usually nonstony; surface runoff is slow. Seasonal water table may be within 1 m during the growing season. Permeability is moderatelty slow to moderate; frost layers may impede water movement in April and May. Native vegetation was tall prairie grasses and shrubs. Present land use is agricultural, mainly for cereal production. These soils have low susceptibility to erosion. They are normally non-saline; some areas may have appreciable salts (saline phases)

A representative soil profile varies from 30 to 40 cm thick, and consists of a black Ap horizon 10 to 20 cm thick, dominantly clay loam texture; a black to dark gray AC horizon 18 to 25 cm thick. The parent material is brown to yellowish brown; in most areas, the deposition is quite uniform, but can be occasionally stratified and banded (former buried surface layers).

The Cranmer soils are a member of the Elva Association as described in the Boissevain-Melita Report, 1978; or part of the clay loam to fine loam group of the Carroll Association in the South Western Soil Report, 1940; or intermediately drained, Blackearth-Meadow member of the Carroll Association (clay loams) of the Rossburn and Virden Soil Report 1956.

## Cromer Series (CRM)

The Cromer series is characterized by Rego Humic Gleysol soil profiles, poor to very poor soil drainage, and parent material of greater than 100 cm of weakly to moderately calcareous clayey (fine textured) stratified lacustrine and fluvial sediments. These soils occur on level to depressional topographic positions in nearly level, flat landscapes or along stream meanders. Surface conditions are usually nonstony; surface runoff is very slow to ponded. Seasonal water table may be at or near the soil surface during the growing season, unless adequately drained. Permeability is very slow in all horizons. Native vegetation is hydrophytic with sedge, cattails and bullrushes. Present land use is mainly native hay and limited grazing; some areas remain as wetland for wildlife. These soils are not susceptible to erosion. Salinity is variable from non to strongly saline.

A representative soil profile varies from 25 to 35 cm thick, and consists of brown organic layer, OM to Oh horizon 5 to 10 cm thick; a black to very dark gray Ah horizon 5 to 10 cm thick of clay texture; and an AC horizon usually less than 10 cm thick. Under cultivation the Ap (mixture of Oh and Ah) is usually 15 to 20 cm thick. The parent material is olive to olive gray with some yellowish brown to strong brown mottles.

Salinity can be a problem in these soils; degree of salts varies from one area to another depending on groundwater conditions. Many Cromer soils occur in local groundwater discharge areas. If salt in the groundwater is high, soluble salts accumulate in the soil profile in sufficient concentration to severely limit the growth of plants that have low salt tolerance. Areas with levels of salinity greater than 4 dS/m have been mapped as the saline phases.

## Cromer, sandy substrate variant (CRM1)

The Cromer, sandy substrate variant identifies similar soils to Cromer that have a sandy substrata within 100 cm of the surface. The solum properties are similar to the Cromer series. The sandy substrata commonly occurs at 75 to 100 cm. Saline phases have also been recognized.

The Cromer soils are the poorly drained, gleyed member of the Pipestone Association as described in the Boissevain-Melita Report 1978; the poorly drained associate, wet meadow soil, of the Pipestone Association of the South Western Soil Report 1940; and the poorly drained member (Meadow) of the Pipestone Association of the Rossburn-Virden Map Sheet 1956.

## Emblem Series (EBL)

The Emblem series is characterized by Rego Humic Gleysol soil profiles, poor soil drainage, and parent material of greater than 100 cm, strongly calcareous, loamy lacustrine sediments. These soils occur on lower slope to depressional topographic positions in very gently sloping to undulating landscapes and along meandering drainage channels. Surface conditions are usually nonstony; surface runoff is very slow to ponded. Seasonal water table may be at or above the surface in spring and within 0.5 m during the growing season unless drainage has been improved. Permeability is moderate to moderately slow. Native vegetation is dominantly hydrophytic with sedge, cattail and bullrush. Present land use consists of native hayland and limit-

ed grazing; some areas remain as wetland for wildlife. These soils are not susceptible to erosion. Salinity is variable from non to strongly saline.

A representative soil profile varies from 25 to 40 cm thick, and consists of a brown to dark brown organic Om or Oh horizon 5 to 10 cm thick; a very dark gray to black Ah (Ahk) horizon 8 to 15 cm thick of dominantly loam texture; and a dark gray to gray AC horizon 5 to 10 cm thick. The parent material is olive gray to light gray with mottles of yellowish brown to strong brown along former root channels.

The Emblem soils are the poorly drained members of the Cameron Association as described in the Boissevain-Melita Report 1978; the fine loamy, hydromorphic associate of the Souris Association; or salinized and carbonated meadow-prairie of the Carroll Association in the South Western Report 1940; or the poorly drained Calcic Meadow of the Carroll loams in the Rossburn-Virden Report, 1956.

Salinity can be a problem in these soils; the degree of salts varies from one area to another depending on the groundwater conditions. Many Emblem soils are situated in local groundwater discharge areas. If the level of soluble salts in the groundwater is high, they may accumulate in the soil profile in sufficient concentration to severely limit the growth of plants that have low salt tolerance. Areas with levels of salinity greater than 4 dS/m have been mapped as saline phases.

## Grande-Clairiere Series (GDC)

The Grande-Clairiere series is characterized by Orthic Regosol soil profiles, rapid soil drainage, and parent material of greater than 2 m weakly calcareous to noncalcareous sandy aeolian sediments. These soils occur on lower to upper topographic positions in undulating to strongly rolling (2-30% slopes), complex, hummocky duned landscapes. Surface conditions are usually non-stony; surface runoff is negligeable. Seasonal water table may be greater than 2 m during the growing season. Permeability is rapid. Native vegetation consists of groves of dominantly trembling aspen, with understory of hazelnut, poison oak, creeping juniper and grasses. Present land use consists of woodland grazing. These soils have high susceptibility to erosion if surface cover is removed. These soils are non saline.

A representative soil profile varies from 5 to 10 cm thick, and consists of thin leaf and organic layer (L-H) 2 to 5 cm thick; and a gray to dark gray, weakly developed Ahej horizon less than 3 cm thick, usually of fine sand texture. The parent material is dominantly fine sand with thin strata of medium sand; color is brownish yellow to light yellowish brown.

The Grande-Clairiere is the dominant member of the Grande-Clairiere Association of the Boissevain-Melita Report 1978; the excessively drained associate - Sand Dunes, of the Souris Association in the South Western Report 1940; and the sandy regosolic soils of Duned sand in the Rossburn-Virden Report 1956.

## Hartney Series (HRY)

The Hartney series is characterized by Gleyed Rego Black, (carbonated) soil profiles, imperfect soil drainage, and parent material of greater than 100 cm of strongly calcareous, loamy lacustrine sediments. These soils occur on lower to mid slope topographic positions in level to complex undulating landscapes. Surface conditions are usually nonstony; surface runoff is slow. Seasonal water table may be near 1 m during the growing season and greater than 2 m during fall and winter. Permeability is moderate; frost layer may impede water movement in April and May. Native vegetation was dominantly tall prairie grasses. Present land use is agricultural, primarily for cereal crop production. These soils are susceptible to wind erosion if adequate surface cover or trash is not provided. Salinity is variable from non to strongly saline.

A representative soil profile varies from 25 to 35 cm thick, and consists of a black Apk horizon 10 to 15 cm thick, dominantly loam texture; a black to very dark gray Ahk horizon 4 to 10 cm thick; and an AC horizon of 8 to 12 cm thick. A light olive gray Cca horizon 7 to 10 cm thick commonly occurs below the solum. The parent material is pale olive to pale yellow with mottles of yellowish brown.

The Hartney soils are the imperfectly drained members of the Cameron Association as described in the Boissevain-Melita Report 1978; or the intermediately drained associate of the Carroll loams in transition to Carbonated Meadow Prairie soil of the Souris fine loams in the South Western Report 1940; or the intermediately drained member - Calcic Blackearth-Meadow of the Carroll loams in the Rossburn-Virden Report 1956.

Salinity can be a problem in these soils; the degree of salinity varies from one area to another depending on the groundwater conditions. Many Hartney soils are situated in local groundwater discharge areas. If salts in the groundwater is high, soluble salt may accumulate in the soil profile in sufficient concentration to severely limit the growth of plants that have low salt tolerance. Areas with levels of salinity greater than 4 dS/m have been mapped as saline phases.

## Lyleton Series (LYT)

The Lyleton series is characterized by Orthic Black soil profiles, moderately well to well soil drainage, and parent material of greater than 100 cm, moderately calcareous coarse loamy lacustrine and fluvial sediments. These soils occur on mid to upper slope topographic positions in gently sloping to gently undulating (1.5-5% slopes), complex, undulating landscapes. Surface conditions are usually nonstony; surface runoff is moderate. Seasonal water table may be greater than 2 m during the growing season. Permeability is moderately rapid to moderate. Native vegetation was dominantly tall prairie grasses and shrubs. Present land use is agricultural, primarily for cereal production. These soils have moderate susceptibility to erosion; some areas have been weakly eroded. These soils are non saline.

A representative soil profile varies from 40 to 55 cm thick, and consists of a black to very dark brown Ap horizon 12 to 15 cm thick with sandy loam to loamy very fine sand texture; a very dark gray to black Ah horizon 18 to 25 cm thick; and a very dark grayish brown Bm horizon 12 to 18 cm thick. A light brownish gray Cca horizon 15 to 20 cm thick commonly occurs below the profile. The pa-

rent material is light brownish gray and usually stratified.

The Lyleton soils are the well drained member of the Lyleton Association as described in the Boissevain-Melita Report 1978; the phytomorphic associate, fine sandy loams of the Souris Association in the South-Western Report 1940; and the well drained Blackearth-like of the Souris fine sandy loams in the Rossburn-Virden Report 1956.

## Marsh Complex (MHC)

The Marsh complex is characterized by very poor soil drainage, and parent material of less than 15 cm of moderately decomposed fen peat over materials of variable mineralogy and texture. They are treated as miscellaneous landscape types. They occur adjacent to water bodies or depressional topographic positions in flat to level, lacustrine landscapes. Surface conditions are usually nonstony, but may vary with the landscape; surface runoff is ponded. Seasonal water table may be 0.5 m above the surface during the growing season and within 1 m of the surface for the balance of the year unless drainage has been improved. Permeability is variable depending on the parent materials. Native vegetation is reeds and sedges. Present land use consists of wetland habitat for wildlife. These soils have negligeable susceptibility to erosion. These areas are usually non to weakly saline.

A representative soil profile varies from 10 to 20 cm thick, and consists of thin surface layer of either muck or mineral material high in organic matter usually less than 15 cm thick; and a black Ahg horizon 2 to 5 cm thick. The parent material is strongly gleyed with colors of olive gray to gray.

The Marsh Complex correlates with the Marsh Complex of the Boissevain-Melita Report 1978; the very poorly drained member recognized by a Marsh symbol in the South Western Report, 1940; and very poorly drained marsh and peaty meadow symbols within various associations in the Rossburn-Virden Report 1956.

In the Oak-Plum Lakes Project, the underlying parent material of the Marsh Complex is inferred to be thin, moderately decomposed fen peat less than 15 cm thick, over loamy lacustrine or fluvial sediment 60 to 75 cm thick over sandy sediments. This interpretation is based on parent material characteristics of soils occurring immediately adjacent to marsh complex areas.

## Martinville Series (MNV)

The Martinville series is characterized by Rego Humic Gleysol soil profiles, poor soil drainage, and parent material of 25 to 100 cm, strongly calcareous, loamy (medium textured) lacustrine sediments overlying moderately calcareous, sandy (coarse textured) lacustrine sediments. These soils occur on toe and depressional topographic positions in gently sloping to gently undulating (0.5-2% slopes) landscapes. Surface conditions are usually nonstony; surface runoff is ponded to very slow. Seasonal water table may be near or above the surface during the growing season. Permeability is moderate in the loamy overlay and moderately rapid in the sandy subsoil. Native vegetation is hydrophytic with sedge and reeds. Present land use consists of native hayland or native grazing. These soils have negligeable susceptibility to erosion under present land use. Salinity is variable from non to strongly saline.

A representative soil profile varies from 25 to 45 cm thick, and consists of a moderately decomposed fen peat layer (Om) of 3 to 10 cm; a strongly calcareous, dark gray Ahk horizon 15 to 30 cm thick; and an AC 0 to 20 cm thick. A prominent Cca is often present, 25 to 50 cm thick. The parent material is dull colored with gray to light gray.

The Martinville soils are the poorly drained members of the Wawanesa Association as described in the Boissevain-Melita Report 1978; these soils would be the Meadow members of the Souris Association probably associated with the fine sandy loams and fine loams reported in the South-Western Report 1940; and the poorly drained Calcic Meadow of the Souris Association in the Rossburn-Virden Report 1956.

Salinity can be a problem in these soils; the degree of salts varies from one area to another depending on the groundwater conditions. Some of the Martinville soils occur in local groundwater discharge areas. If salts in the groundwater are high, soluble salts accumulate in the soil profile in sufficient concentration to severely limit the growth of plants that have low salt tolerance. Areas with levels of salinity greater than 4 dS/m have been mapped as saline phases.

## Oak Lake Series (OKL)

The Oak Lake series is characterized by Rego Humic Gleysol (carbonated) soil profiles, poor soil drainage, and parent material of greater than 100 cm weakly to moderately calcareous sandy lacustrine sediments. These soils occur in toe and depressional topographic positions within complex undulating landscapes with level to very gentle slopes. Surface conditions are usually nonstony; surface runoff is ponded to very slow. Seasonal water table may be at or near the surface during the growing season, unless adequately drained. Permeability is moderately rapid in all horizons; frost layers may impede water movement in April and May. Native vegetation is hydrophytic with sedges, cattails and grasses. Present land use consists of native hayland and pasture; some areas are used as wetland habitat for wildlife. These soils have negligeable susceptibility to erosion under present conditions. Salinity is variable from non to strongly saline.

A representative soil profile varies from 25 to 50 cm thick, and consists of a moderately decomposed organic layer (Om) 2 to 10 cm thick; a black to very dark gray Ahk horizon 15 to 20 cm thick of loamy fine sand texture; and a gray AC from 2 to 25 cm. A lime accumulation layer (Cca) is not common, but in some landscapes may be 15 to 25 cm thick. The parent material is dominantly fine sand with thin strata of loamy fine sand or medium sand, dominantly gray brown in color with prominent mottles and iron concretions.

The Oak Lake soils are the poorly drained member of the Souris Association as described in the Boissevain-Melita Report 1978; the poorly drained (H) associate or Meadow soil on the sands of the Souris Association reported in the South-Western Report 1940, or the poorly drained Calcic Meadow of the Souris loamy fine sand in the Rossburn-Virden Report 1956.

Salinity can be a problem in these soils; the degree of salts varies from one area to another depending on the groundwater conditions. Many Oak Lake soils occur in local groundwater discharge areas. If salts in the groundwater is high, soluble salts may accumulate in the soil profile in

sufficient concentration to limit the growth of plants that have low salt tolerance. Areas with levels of salinity greater than 4 dS/m have been mapped as the saline phases.

## Pipestone Series (PPT)

The Pipestone series is characterized by Gleyed Rego Black soil profiles, imperfect soil drainage, and parent material greater than 100 cm of weakly to moderately calcareous clayey (fine textured), stratified lacustrine and fluvial sediments. Sandy sediments occur at variable depths ranging from 1.2 to 3 m of the surface. These soils occur on slightly better drained topographic positions in level to very gently undulating landscapes. Surface conditions are usually nonstony; surface runoff is very slow. Seasonal water table may be within 1 m during the growing season. Permeability is moderately slow in soils with angular blocky structure to very slow in soils with solonetzic characteristics. Native vegetation was tall prairie grasses. Present land use is agricultural, mainly cereal production and some forage. These soils are susceptible to erosion if left relatively free of surface cover, particularly in early spring. Salinity is variable from non to strongly saline.

A representative soil profile varies from 25 to 40 cm thick, and consists of a black to very dark gray Ap horizon commonly 15 cm thick; a black to very dark gray Ah horizon 5 to 10 cm thick; and an AC horizon 10 to 15 cm thick. The parent material is stratified with strata ranging from silty clay to fine clay.

The Pipestone series is the imperfectly drained member of the Pipestone Association as described in the Boissevain-Melita Report 1978; the intermediately drained Meadow prairie soil of the Pipestone Association of the South Western Report 1940; and the intermediately drained Black-earth-Meadow of the Pipestone Association in the Rossburn-Virden Report 1956.

Salinity can be a problem in these soils; the degree of salts varies from one area to another depending on the groundwater conditions. Many Pipestone soils occur in local groundwater discharge areas. If salts in the groundwater are high, soluble salts can accumulate in the soil profile in sufficient concentration to severely limit the growth of plants that have low salt tolerance. Areas with levels of salinity greater than 4 dS/m have been mapped as the saline phases.

Within the present study, soils with weak solonetzic structure (Bnj) occur as inclusions with the Pipestone soils. At a number of inspection sites, the soils had a columnar B1 horizon and a saline, massive B2. It appears as though some of these soils have undergone a resalinization.

## Pipestone, sand substrate variant (PPT1)

The Pipestone, sandy substrate variant identifies similar soils to the Pipestone that have a sandy substrata within 100 cm of the surface. Their soil profile properties are similar to the Pipestone series. The sandy substrata commonly occurs at 75 to 100 cm. Saline phases have also been recognized.

## Plum Lake Series (PAK)

The Plum Lake series is characterized by Rego Humic Gleysol (carbonated) soil profiles, poor soil drainage, and parent material of greater than 100 cm moderately calcareous, coarse loamy lacustrine sediments. These soils occur on toe and depressional topographic positions in gently sloping to gently undulating (0.5-2% slopes), landscapes. Surface conditions are usually nonstony; surface runoff is ponded to very slow. Seasonal water table may be near or above the surface during the growing season. Permeability is moderately rapid in the surface and subsoil horizons, and moderate to moderately slow in horizons with appreciable secondary carbonates. Native vegetation is hydrophytic with sedges, reeds and grasses. Present land use consists of native hayland or native grazing. These soils have negligeable susceptibility to erosion under present land use. Some of these soils may be saline.

A representative soil profile varies from 25 to 40 cm thick, and consists of a moderately decomposed organic layer (Om) of 2 to 5 cm; a very dark gray, Ahk horizon 15 to 25 cm thick; and an olive gray AC horizon 10 to 20 cm thick. A lime accumulation layer 5 to 15 cm thick may be present. The parent material is olive to pale olive with yellowish brown mottles.

The Plum Lake soils are the poorly drained members of the Lyleton Association as described in the Boissevain-Melita Report 1978; the poorly drained sandy loam Meadow of the Souris Association in the South Western Report 1940; and the poorly drained Calcic Meadow of the Souris fine sandy loam in the Rossburn-Virden Report 1956.

## Ralston Series (RTO)

The Ralston series is characterized by Gleyed Regosol soil profiles, imperfect soil drainage, and parent material of greater than 2 m weakly calcareous to noncalcareous sandy aeolian sediments. These pedons occur on lower concave topographic positions in gently sloping complex, hummocky duned landscapes. Surface conditions are usually nonstony; surface runoff is slow to negligeable. Seasonal water table may be within 1 m during the early part of the growing season. Permeability is rapid. Native vegetation is dominantly trembling aspen, with creeping juniper, rose, saskatoons and grasses. Present land use consists of woodland grazing. These soils have high susceptibility to erosion if surface is removed and left exposed. These soils are non saline.

The feebly developed soil profile varies from 5 to 15 cm thick, and consists of a thin leaf and organic layer (L-H) 5 to 10 cm thick; and a gray to dark gray Ah horizon 5 to 20 cm thick, usually of fine sand texture. The parent material is pale brown, dominantly fine sand with thin strata of medium sand. In some locations, a black to brown layer, commonly 5 to 10 cm thick containing abundant iron and manganese concretions, mottles and stains may occur within 1 meter of the surface; some of these layers may be 30 to 60 cm thick. This layer appears to affect the moisture regime since it is less permeable than the horizons above and below it.

The Ralston soil is the imperfectly drained member of the Grande-Clairiere Association as described in the Boissevain-Melita Report 1978; they are inclusions within the Sand Dunes - Souris Association of the South Western Report 1940; and they are inclusions within the Duned Sands

local soil areas of the Rossburn-Virden Report 1956.

## Scarth Series (SCH)

The Scarth series is characterized by Rego Black soil profiles, well to moderately well soil drainage, and parent material of greater than 100 cm weakly to moderately calcareous sandy (coarse textured) lacustrine sediments. These soils occur on the apex and upper slope topographic positions (2 to 9 percent slopes), in undulating to hummocky landscapes. Surface conditions are usually nonstony; surface runoff is moderate. Seasonal water table may be greater than 2 m during the growing season. Permeability is moderately rapid to rapid. Native vegetation is short prairie grasses. Present land use is agricultural, primarily for cereal and forage production. These soils have high susceptibility to erosion if sufficient surface cover is not provided. These soils are non saline.

The solum varies from 20 to 30 cm thick, and consists of a very dark gray Ap horizon 15 to 20 cm thick, of fine sand to loamy fine sand texture; and a dark gray to grayish brown AC horizon 5 to 15 cm thick. A lime accumulation horizon 5 to 10 cm thick may be present. The parent material is grayish brown fine sand.

The Scarth soil is one of the well drained members of the Souris Association as described in the Boissevain-Melita Report 1978; the phytomorphic member of the Souris Association in the South Western Report 1940; and the Blackearth-like (or Thin Blackearth) member of the Souris loamy fine sand in the Rossburn-Virden Report 1956.

Some of the cultivated areas have been affected by wind erosion. Where considerable soil has been lost from the surface horizon(s) or where additions to the surface have occurred, erosion or overblown phase(s) have been mapped.

## Souris Series (SOU)

The Souris series is characterized by Gleyed Rego Black soil profiles, imperfect soil drainage, and parent material of greater than 100 cm of weakly to moderately calcareous sandy lacustrine sediments. These soils occur on lower to mid slope topographic positions in level to complex, undulating landscapes. Surface conditions are usually nonstony; surface runoff is slow. Seasonal water table may be within 1 m during the growing season and at 2 m or more during fall and winter. Permeability is moderately rapid to rapid; frost layers may impede water movement in April and May. Native vegetation is dominantly tall prairie grasses and shrubs. Present land use is agricultural, primarily for cereal and forage production. These soils are susceptible to wind erosion if sufficient surface cover is not provided. Salinity is variable from non to weakly saline.

A representative soil profile varies from 30 to 50 cm thick, and consists of a very dark gray Apk horizon 15 to 20 cm thick, with fine sand to loamy fine sand texture; a very dark gray Ahk, 5 to 10 cm thick; and a gray to grayish brown AC horizon 2 to 15 cm thick. Secondary carbonate accumulation in the A horizon (Aca), commonly 10 to 15 cm thick, may be present in some areas. The parent material is yellowish brown, with strong brown to brownish yellow mottles. A lime accumulation (Cca) may be present below the AC in some areas.

The Souris soils are the imperfectly drained members of the Souris Association as described in the Boissevain-Melita Report 1978; the intermediately drained, carbonated, Meadow-Prairie associate of the Souris Association of the South Western Report 1940; and the intermediately drained Blackearth-Meadow associate of the Souris loamy fine sands of the Rossburn-Virden Report 1956.

Salinity can occur in these soils; the degree of salinity varies from one area to another depending on the groundwater salinity. If the groundwater has appreciable salts, they may move upward in the soil profile in sufficient quantity to influence the growth of plants that have low salt tolerance. Areas with levels of salinity greater than 4 dS/m have been mapped as saline phases.

**Stanton Series (STU)**

The Stanton series is characterized by Orthic Black soil profiles, well to moderately well soil drainage, and parent material of greater than 100 cm, weakly to moderately calcareous, sandy lacustrine sediments. These soils occur on mid to upper slope topographic positions with a range from 2 to 15 percent slopes, on complex undulating landscapes. Surface conditions are usually nonstony; surface runoff is slow to moderate depending on slope conditions and rainfall conditions. Seasonal water table may be greater than 2 m during the growing season and greater than 3 m during fall and winter. Permeability is moderately rapid to rapid. Native vegetation is dominantly grasses with few shrubs. Present land use is agricultural, primarily for cereal or forage production. These soils are susceptible to wind erosion if sufficient surface cover is not provided. These soils are nonsaline.

The solum varies from 30 to 75 cm thick, and consists of a very dark gray to black Ap horizon 15 to 20 cm thick, fine sand to loamy fine sand texture; very dark gray Ah horizon 5 to 15 cm thick; and a dark brown to brown Bm horizon 25 to 50 cm thick. The parent material is stratified, grayish brown fine sand to loamy fine sand.

The Stanton soil is one of the well drained members of the Souris Association as described in the Boissevain-Melita Report 1978; the phytomorphic member of the Souris Association in the South Western Report 1940; and the Blackearth-like member of the Souris loamy fine sand in the Rossburn-Virden Report 1956.

Some of the vultivated areas have been affected by wind erosion. Where considerable soil has been lost from the surface horizon(s) or where additions to the surface have occurred, the erosion or overblown phase(s) have been mapped.

**Switzer Series (SWZ)**

The Switzer series is characterized by Gleyed Rego Black soil profiles, imperfect soil drainage, and parent material of greater than 100 cm moderately calcareous, coarse loamy lacustrine sediments. These soils occur on lower to mid slope topographic positions with slopes of less than 2 percent, on complex undulating landscapes. Surface conditions are usually nonstony; surface runoff is moderately slow. Seasonal water table may be within 1 m during the growing season and greater than 2 m in the fall and winter. Permeability is moderate; frost layers may impede water movement in April and May. Native vegetation is tall prairie grasses and shrubs. Present land use is agricultural, primarily for cereal and forage production. These soils

are susceptible to wind erosion if sufficient surface cover is not provided. These soils may be saline in some landscapes.

A representative soil profile varies from 25 to 30 cm thick, and consists of a black Apk horizon, 12 to 15 cm thick, loamy very fine sand to fine sandy loam surface texture; and a dark gray AC horizon 12 to 15 cm thick. A gray lime accumulation layer (Cca) is commonly present below the solum. The parent material is stratified and may grade to fine sand or loamy fine sand below 1 m.

The Switzer soils are the imperfectly drained member of the Lyleton Association as described in the Boissevain-Melita Report 1978; the intermediately drained (P-H) carbonated Meadow-Prairie soils of the Souris sandy loams in the South Western Report 1940; and the intermediately drained Blackearth-Meadow associate of the Souris fine sandy loam of the Rossuburn-Virden Report 1956.

Salinity can occur in these soils; the degree of salinity varies from one area to another depending on the groundwater salinity. If the groundwater has appreciable salts, they may move upward in the soil profile in sufficient quantity to influence the growth of plants that have low salt tolerance. Areas with levels of salinity greater than 4 dS/m have been mapped as saline phases.

## Wawanesa Series (WWS)

The Wawanesa series is characterized by Gleyed Rego Black (carbonated) soil profiles, imperfect soil drainage, and parent materials of 25 to 100 cm moderately to strongly calcareous loamy (medium textured) lacustrine sediments overlying strongly calcareous sandy (coarse textured) lacustrine sediments. These soils occur on lower to mid slope topographic positions with slopes usually less than 2 percent, in complex undulating landscapes. Surface conditions are usually nonstony; surface runoff is slow. Seasonal water table may be within 1 m in the early part of the growing season and usually greater than 2 m in fall and winter. Permeability is moderate; frost layers may impede water movement in April and May. Native vegetation is tall prairie grasses. Present land use is agricultural, primarily for cereal and forage production, or as native hayland in poorly drained complexes. These soils are susceptible to wind erosion if adequate surface cover is not provided. These soils may vary in salinity from non to strongly saline.

A representative soil profile varies from 20 to 50 cm thick, and consists of a very dark gray to black Ahk horizon 20 to 30 cm thick, silt loam to loam texture; and a dark gray AC horizon; considerable secondary carbonates may be present in the profile. A lime accumulation (Cca) horizon may also be present below the profile. The parent material is light gray in the loamy sediments and yellowish brown with strong brown to brownish yellow mottles in the sandy sediments.

The Wawanesa soils have the characteristics of Wawanesa soils as described in the Boissevain-Melita Report 1978; the intermediately drained carbonated Meadow-Prairie associate of the Souris fine loams in the South Western Report 1940; and as part of the intermediately drained Blackearth-Meadow associate within the Souris fine sandy loam of the Rossburn-Virden Report 1956.

Salinity can be a problem in these soils; the degree of salts varies from one area to another depending on the groundwater properties. Many

Wawanesa soils occur in local groundwater discharge areas. If salts in the groundwater is high, soluble salts may accumulate in the soil profile in sufficient quantities to severely limit the growth of plants that have low salt tolerance. Areas with levels of salinity greater than 4 dS/m have been mapped as saline phases.

# PART 4

# USE AND MANAGEMENT INTERPRETATIONS OF SOILS

## 4.1 INTRODUCTION

This section provides predictions of performance or soil suitability ratings for various uses of soils based on field observations of soil and landscape characteristics, laboratory data and on observations of soil behavior under specified conditions of land use and management. Suitability ratings or interpretations are intended only to serve as guides for planners and managers. Caution, with an understanding of the limitations of the soil map must be exercised when applying suitability ratings to soil map units. The value of any rating or interpretation depends upon the nature and composition of individual map unit delineations which in turn depends on the scale of mapping and intensity of ground truthing employed in the survey.

In this section, interpretive soil information is provided for the following land use evaluations:

1. Agriculture
   a) dryland farming capability
   b) irrigation suitability
2. Engineering Uses
3. Recreation Uses

## 4.2 SOIL CAPABILITY FOR AGRICULTURE

### Dryland Agriculture

Soil capability classification for dryland agriculture is based on evaluation of both internal and external soil characteristics that influence soil suitability and limitations for agricultural use. In this classification, mineral soils are grouped into capability classes, subclasses and units based on their limitations for dryland farming, risk of damage when the soils are used and the way they respond to management (ARDA, 1965). There are seven capability classes, each of which groups soils together that have the same relative degree of limitation or hazard for agricultural use. The limitation becomes progressively greater from Class 1 to Class 7.

Soil capability class indicates the general suitability of the soils for agriculture. The first three classes are considered capable of sustained production of common field crops, the fourth is marginal for sustained arable culture, the fifth is suitable only for improved permanent pasture, the sixth is capable of use only for native pasture while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture.

Soil Capability subclasses are divisions within classes which group soils with similar kinds of limitations and hazards for agricultural use. The various kinds of limita-

tions recognized at the subclass level are defined in Table 5.

Soil capability units are divisions within the subclass category that groups soils together that will respond similarly to a given management input.

The definition of the soil capability classes and grouping of the soils into the capability subclasses and units are as follows:

Class 1

Soils in this class have no important limitations for crop use. The soils have level or gently sloping topography; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility; soils are moderately high to high in productivity for a wide range of cereal and special crops. The soils in this class include:

CMR Cameron

Class 2

Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

2M - These are moderately well drained to imperfectly drained soils developed on nearly level to gently sloping sandy sediments. They are easily tilled and are readily permeable to roots, air and moisture. They have a low to moderate organic matter content, and moderately low moisture retention capacity. They are somewhat droughty, and if not protected, are susceptible to wind erosion. It is important to maintain organic matter in these soils through the addition of organic residues such as straw, barnyard manure, or green manure crops to prevent wind erosion, to increase water retention capacity and to build up fertility. These soils are very responsive to additions of nitrogen, phosphorus and in some cases, potassium fertilizers. The soils are:

LYT Lyleton

2MT - These soils have similar properties as 2M above, but have undulating to gently undulating topography with 2-5 percent slopes. They have had some surface erosion. The soils are:

LYT/xcxx
LYT/ocxx
LYT/1cxx

TABLE 5 Agricultural Capability Subclass Limitations

C - Adverse climate: This subclass denotes a significant adverse climate for crop production as compared to the "median" climate which is defined as one with sufficiently high growing season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

D - Undesirable soil structure and/or low permeability: This subclass is used for soils difficult to till, or which absorb water very slowly or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

E - Erosion: Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

F - Low fertility: This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates or presence of toxic compounds.

I - Inundation by streams or lakes: This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

L - Coarse wood fragments: In the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

M - Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

N - Salinity: Designates soils which are adversely affected by the presence of soluble salts.

P - Stoniness: This subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

R - Consolidated bedrock: This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 1 meter from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

T - Topography: This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

W - Excess water: Subclass W is made up of soils where excess water other than that brought about by inundation is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

X - Cumulative minor adverse characteristics: This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not serious enough to affect the class rating.

2W1 - The soils in this class are imperfectly drained, fine to moderately fine textured soils on level to very gently sloping topography. They have a moderately high content of organic matter. They have a slow to very slow permeability. The main soil management problems are maintenance of tilth and good aeration. If cultivated when they are too moist or dry, large massive lumps will result, forming a poor seed bed. The soils take longer to warm up in the spring than medium to moderately coarse textured soils and usually take longer to dry out following rains. Incorporation of stubble or green manure crops is a good practice to maintain good surface structure and improve permeability. Shallow surface drains should be planned to remove any standing water. Drains and natural intermittent streams or creeks should be made saucer-shaped and seeded down to permanent grass to prevent siltation and to allow implement traffic. The soils in this subclass are:

CME Cranmer
PPT Pipestone
PPT1 Pipestone, sandy substrate

2W2 - The soils in this class are imperfectly drained, moderately coarse to medium textured on level to very gently sloping topography. Main soil management problems are maintenance of tilth and good aeration. They are subject to short periods of wetness or high water table during the spring, following heavy rains, or in years of above normal precipitation. Shallow surface drains should be planned to remove excess water. The soils in this subclass are:

HRY Hartney
SWZ Switzer
WWS Wawanesa

2T - These are well to imperfectly drained, medium to moderately fine textured soils on undulating to gently undulating topography. The conservation practises of continuous cropping and returning the stubble is recommended to minimize erosion losses by wind and water. The soils are:

CMR/xcxx
CMR/1cxx

Class 3

Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. The limitations include one or more of the following: moderate climatic limitation, erosion, structure or permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water to plants, stoniness and depth of soil to consolidated bedrock. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops.

3M - These soils occur on level to very gently sloping, moderately coarse to coarse textured sandy deposits. They have rapid permeability, low water retention capacity, and low to moderate organic matter content. They are subject to droughti-

ness in the early summer during periods of low precipitation. Wind erosion is a problem if the land remains bare. They are relatively low in natural fertility, but will respond well to additions of nitrogen, phosphorus and potash. Organic residues such as barnyard manure, stubble, straw or green manure crops should be incorporated into the soil regularly to improve or maintain the organic matter status, increase water retention capacity, prevent erosion and to build up the fertility. Under good management, these soils will produce good to excellent crops of cereals, forage and hay. The soils in this subclass are:

SOU Souris
SOU/xcxx

3ME - These are soils similar to above with slight erosion or overblown layers. Management is similar to 3M soils.

SOU/1xxx
SOU/0xxx

3NM - These are imperfectly drained, slightly to moderately saline, coarse to moderately coarse textured soils on level to very gently sloping topography. Crop growth is quite variable in these soils depending on moisture conditions and amount of salts present. Management problems are similar to 3M and 3NW soils. The soils are:

SOU/xxxs Souris
SOU/xcxs

3NW1- These are imperfectly drained, slightly to moderately saline, fine textured soils on level to very gently sloping topography. Crop growth is quite variable on these soils depending on the moisture conditions during the season and the amount of salts present. Degree of salinity is quite variable not only in a horizontal direction or at different sites within an area, but also in a vertical direction. Salts may also be translocated either during the year or over a period of years by capillary rise of saline water and subsequent evaporation resulting in a concentration of salts. The usual method to decrease salinity in soils is to improve drainage, avoid the practice of summerfallow and grow crops that will help maintain soil permeability. These soils are able to produce good crops of cereals, forage and hay crops under good management. The soils in this unit are:

PPT/xxxs Pipestone
PPT1/xxxs

3NW2- These are imperfectly drained, slightly to moderately saline, moderately coarse to moderately fine textured soils on level to very gently sloping topography. Degree of salinity is quite variable throughout areas of these soils and the effect on crops is also very variable depending on the type of crop grown and moisture conditions throughout the growing season. These soils will produce good crops of cereals, forage and hay under good management and fertilizer practice. The soils are:

HRY/xcxs Hartney
SWZ/xxxs Switzer
WWS/xxxs Wavanesa

3T - The topography on which these

soils occur is undulating to gently rolling. The major management problem is to overcome the complex topographic pattern which imposes an obstacle to cultivation and runoff. Since these soils have shallower profile development, it is necessary to incorporate considerable crop residue, manure or green manure crops as possible to maintain good tilth. The soils are:

LYT/xdxx Lyleton

Class 4

Soils in this class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops, or the yield for a range of crops may be low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a specially adapted crop. The limitations include the adverse effects of one or more of the following: climate, accumulative undesirable soil characteristics, low fertility, deficiencies in the storage capacity or release of soil moisture to plants, structure or permeability, salinity, erosion, topography, overflow, wetness, stoniness, and depth of soil to consolidated bedrock.

4M - These are sandy to gravelly coarse textured, imperfectly to well drained soils that are droughty. They are low in natural fertility and low in organic matter. Wind erosion is a hazard in cultivated areas. Organic residues such as barnyard manure, stubble and green manure crops should be returned to the soil to prevent erosion, build up nutrient levels, and increase water retention capacity. These soils are suitable for production of forage and cereal crops under good management. The soils in this subclass are:

RTO Rutledge
STU Stanton
STU/1xxx
STU/0xxx
STU/xcxx

4ME - These soils are similar to the 4M, and have had the surface horizon affected by erosion. Management should be similar to 4M above, with greater precaution to minimize further erosion of the soil. The soils are:

STU/1cxx

4N - These poorly to imperfectly drained, medium to fine textured soils occur in depressional to level positions in the landscape and are moderately saline. They are also subject to ponding for periods of time during spring runoff and after heavy summer rains. If adequate artificial drainage is provided, cereal grain and forage crop production is possible. The soils in this class are:

PPT/xxxt Pipestone
PPT1/xxxt
WWS/xxxt Wawanesa

4TM - These are moderately well drained, coarse textured soils developed on sandy deposits. These soils occur in undulating to moderately rolling topogra-

phy, and may be droughty and susceptible to wind erosion in dry seasons. Soil conservation practices such as returning trash to the soils is strongly recommended if these soils are continuously cultivated. These soils are:

SCH/1dxx Scarth
STU/1dxx Stanton

Class 5

Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. These soils have such serious soil, climatic or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing and water control.

Some soils in Class 5 can be used for cultivated field crops provided unusually intensive management is used. Some of these soils are also adapted to special crops requiring soil conditions unlike those needed by the common crops.

5M - These coarse textured soils occur on irregular, very gently to moderately sloping topography. They are rapidly drained and are low in water-holding capacity. As a result of rapid permeability, these soils are moderately severely affected by droughtiness. These soils are:

GDC/xcxx Grande-Clairiere

5N - These are imperfectly to somewhat poorly drained fine and medium textured soils on level to very gently sloping terrain. Surface runoff is slow and internal drainage is impeded by very low permeability and a high water table in the spring. In addition, salinity conditions permit only salt tolerant forage crops to be grown. The soils are:

HRY/xcxu Hartney
PPT/xxxu Pipestone
WWS/xxxu Wawanesa

5W - These soils are slowly to very slowly permeable and subject to frequent ponding which may persist for considerable periods of time. These soils occur in closed depressional to level areas and are rarely used for cereal crops. In most seasons native hay may be put up on these soils. Where feasible, artificial drainage could improve these soils for cereal and forage production (rate as 3W if drained adequately). These soils are:

CRM Cromer
CRM/xxxs
CRM1
CRM1/xxxs
CRM1/xxxt

Class 6

Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery, or because the soils are not respon-

sive to improvement practices, or because stock watering facilities are inadequate.

6M - These are well drained, coarse textured soils on moderate to steep slopes which have very low water holding capacities, and low fertility. The soils are:

GDC/xdxx Grande-Clairiere
GDC/xexx
GDC/xfxx

6W - These are poorly drained depressional areas which are saturated or covered with water for much of the year. They are not suitable for agricultural crops. They are only marginally suitable for native hay unless drainage can be improved. For the most part, they are suited for native pasture. These soils are:

CRM/xxxt Cromer
CRMp/xxxt
EBL Emblem
EBL/xxxs
MNV Martinville
MNV/xxxs
MNV/xxxt
OKL Oak Lake
OKL/xxxs
OKL/xxxt
OKLp/xxxt
PAK Plum Lake

6NW - These are poorly drained, strongly saline soils on sandy to fine textured sediments occurring on nearly level to gently undulating landscapes. Salinity conditions permit only salt tolerant species to grow. Utilization of these soils is limited to native hay or grazing. The soils are:

CRM/xxxu Cromer
EBL/xxxu Emblem
MNV/xxxu Martinville
OKL/xxxu Oak Lake

Class 7

Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

MHC Marsh
ZZ Water

A summary of the soils showing their major characteristics and their interpretive classification for dryland agriculture is presented in Table 6.

TABLE. 6 AGRICULTURE CAPABILITY CLASSES FOR SOILS

| Map Symbol and Phase | Soil Name | Total Extent Area (ha) | Agricultural Capability Class | Irrigation Suitability |
|---|---|---|---|---|
| CME | Cranmer | 16 | 2W | 2D |
| CMR | Cameron | 49 | 1 | 1 |
| CMR | Cameron | 13 | 1 | 1 |
| CMR /1cxx | Cameron | 50 | 2T | 2T |
| CRM | Cromer | 14 | 5W | 4D |
| CRM /xxxs | Cromer | 151 | 5W | 4D |
| CRM /xxxt | Cromer | 458 | 6W | 4DS |
| CRMp /xxxt | Cromer | 110 | 6W | 4DS |
| CRM /xxxu | Cromer | 125 | 6NW | 4DS |
| CRM1 | Cromer | 22 | 5W | 4D |
| CRM1 /xxxs | Cromer | 94 | 5W | 4D |
| CRM1 /xxxt | Cromer | 399 | 6W | 4DS |
| CRM1 /xxxu | Cromer | 49 | 6NW | 4DS |
| EBL | Emblem | 23 | 6W | 4D |
| EBL /xxxs | Emblem | 55 | 6W | 4D |
| EBL /xxxu | Emblem | 13 | 6NW | 4DS |
| GDC /xcxx | Grande-Clairiere | 363 | 5M | 3S |
| GDC /xdxx | Grande-Clairiere | 436 | 6M | 4ST |
| GDC /xexx | Grande-Clairiere | 4 | 6M | 4ST |
| GDC /xfxx | Grande-Clairiere | 230 | 6M | 4ST |
| HRY | Hartney | 104 | 2W | 2D |
| HRY /xcxu | Hartney | 13 | 5N | 4SD |
| LYT | Lyleton | 47 | 2M | 1 |
| LYT /xcxx | Lyleton | 233 | 2MT | 2T |
| LYT /0cxx | Lyleton | 38 | 2MT | 2T |
| LYT /1cxx | Lyleton | 20 | 2MT | 2T |
| LYT /xdxx | Lyleton | 35 | 3T | 3T |
| MHC | Marsh Complex | 1533 | 7W | 4D |
| MNV | Martinville | 863 | 6W | 4D |
| MNV /xxxs | Martinville | 599 | 6W | 4D |
| MNV /xxxt | Martinville | 147 | 6W | 4DS |
| MNV /xxxu | Martinville | 94 | 6NW | 4DS |
| OKL | Oak Lake | 176 | 6W | 4D |
| OKL /xxxs | Oak Lake | 620 | 6W | 4DS |
| OKL /xxxt | Oak Lake | 263 | 6W | 4DS |
| OKL /xxxu | Oak Lake | 10 | 6NW | 4DS |
| OKLp /xxxt | Oak Lake | 11 | 6W | 4DS |
| PAK | Plum Lake | 83 | 6W | 4D |
| PPT /xxxs | Pipestone | 266 | 3NW | 4S |
| PPT /xxxt | Pipestone | 68 | 4N | 4S |

TABLE. 6 AGRICULTURE CAPABILITY CLASSES FOR SOILS

| Map Symbol and Phase | Soil Name | Total Extent Area (ha) | Agricultural Capability Class | Irrigation Suitability |
|---|---|---|---|---|
| PPT1 | Pipestone | 265 | 2W | 4S |
| PPT1 /xxxs | Pipestone | 179 | 3NW | 4S |
| PPT1 /xxxu | Pipestone | 25 | 5N | 4S |
| RTO | Ralston | 92 | 4M | 3S |
| SCH /1dxx | Scarth | 97 | 4TM | 3ST |
| SOU | Souris | 774 | 4M | 3SD |
| SOU /1xxx | Souris | 103 | 3ME | 3SD |
| SOU /0xxx | Souris | 13 | 3ME | 3SD |
| SOU /xxxs | Souris | 27 | 3NM | 3SD |
| SOU /xcxx | Souris | 507 | 3M | 3SD |
| SOU /xcxs | Souris | 85 | 3NM | 3SD |
| STU | Stanton | 208 | 4M | 3S |
| STU /1xxx | Stanton | 118 | 4M | 3S |
| STU /0xxx | Stanton | 58 | 4M | 3S |
| STU /xcxx | Stanton | 563 | 4M | 3S |
| STU /1cxx | Stanton | 64 | 4ME | 3S |
| STU /1dxx | Stanton | 23 | 4TM | 3ST |
| SWZ | Switzer | 88 | 2W | 2D |
| SWZ /xxxs | Switzer | 84 | 3NW | 3S |
| WWS | Wawanesa | 951 | 2W | 2S |
| WWS /xxxs | Wawanesa | 103 | 3NW | 3SD |
| WWS /xxxt | Wawanesa | 21 | 4N | 4SD |
| WWS /xxxu | Wawanesa | 8 | 5N | 4SD |
| ZZZ | Water | 3023 | 7W | 4D |

## 4.3 IRRIGATION SUITABILITY

Irrigation suitability of soils is a relative rating to indicate their limitation for sustained production, risk of damage or crop losses, and the ability to maintain favorable soil properties under long term irrigation use. Since the land was mapped on the series-phase basis, a rating for a particular member is provided using pertinent guidelines of Land Classification for Irrigation.

The classification of land for irrigation suitability involves an evaluation of physical, economic and sociological factors of the area. Physical factors such as soil, water, and climate determine the potential of an area to produce crops. The economic factors determine the kind of crops grown, and the monetary return that might be expected. The less tangible sociological factors include the available human resources and the influences that intensive and specialized cultural practises may have on the community. However, from the standpoint of determining the suitability of soil for irrigation, only the physical factors of the land resource will be considered in this report.

Soil classification, as a systematic procedure for identifying genetic soil variability, provides a sound basis for assessing the suitability of land resources for irrigation. The irrigation suitability classification for land is based on predictions of soil behavior under controlled conditions of soil moisture and intensive cultural practises. It requires a comprehensive knowledge of existing soil properties such as the natural soil water regime and the degree of salinity. These two factors are particularly important because of their affect on plant growth and because they are the properties most susceptible to change under drastically altered soil water regimes. For irrigation purposes, both salinity and drainage must be appraised in terms of the anticipated effects on future productivity.

It is emphasized that, at this stage, the properties of the series and phases are rated, not the land in relation to other soil units in the landscape. This rating is a first approximation for general use to be used in conjunction with adjacent soil members, drilling results, and land use evaluation in order to make a final land classification rating determined by evaluating the nature of both the internal and external characteristics (PFRA 1964; Michalyna and Smith 1972). The classification of soils for irrigation suitability consists of two categories: class and subclass.

The suitability class groups soils having the same relative suitability or degree of limitation or hazard for irrigation use. Four classes are utilized grading from 1, which is very good to 4, which is poor. The four classes are:

1 - Very good: These are soils of fine sandy loam to clay loam texture which are well suited for irrigation use. The soils have good water retention capacity, good permeability, low salt content, good drainage and low general gradient of land surface.

2 - Good: These are soils of loamy fine sand to light clay texture which are moderately well suited for irrigation use. Slight limitation to use results from soil factors such as water holding capacity, permeability, depth of material, salt content, topographic factors such as slope and pattern or drainage restric-

tions arising from surface drainage and depth to water table.

3 - Fair: These are coarse or fine textured soils which are fair to marginally suitable because of some unfavourable characteristics that limit production and cause management problems under irrigation use. Soil, topographic or drainage factors are more restrictive than in Class 2.

4 - Poor: These are soils that are considered poor to unsuitable for irrigation use because of severe drainage problems, impermeable geologic material, salinity, very low water holding capacity, very rapid permeability, topography or a combination of these problems.

The suitability subclass identifies soils with similar kinds of limitations and hazards related to both internal and external soil characteristics. The characteristics are S for soil factors, T for external and topographic factors, and D for drainage or drainability constraints.

S - Soil factors are texture, water holding capacity, hydraulic conductivity (or permeability), uniformity and depth of geological deposits, depth to impervious or slowly permeable layer, level of soluble salts and relative sodium level (SAR).

T - External features are those that affect the transport of water and any obstructions to operation of equipment or affect adequate size of land. These factors are the type of topography and slope gradients, degree of stones or rock. (The size and shape of field, surface levelling requirement and vegetative covering are not included in the rating at this point, but are considered at the next step of land classification).

D - Drainage is rated on the basis of the implied internal and surface wetness of the soil series and phase at this stage. (For a land classification, the drainability of the land area in conjunction with a satisfactory outlet are considered).

The land classification criteria for irrigation are summarized in Table 7. The soils are evaluated for irrigation suitability in Table 6.

## 4.4 SOIL SUITABILITY FOR SELECTED ENGINEERING USES

This section provides information which can be used by engineers and land use planners concerned with engineering and related geotechnical aspects of soil. It is intended to supplement the information on the soil map with additional data on engineering properties of soils.

The criteria used to evaluate soil suitability for selected engineering and related recreational uses are adopted from guides found in Coen, et al. (1977), and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture (1971), and the Canada Soil Survey Committee (1973).

### Definition of Soil Suitability Classes

Evaluation of soil suitability for engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to eval-

uate both mineral and organic soils and hence, mapping units for selected uses. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long term effects of the potential use on the behavior of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

G-Good: Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.

F-Fair: Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.

P-Poor: Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require the removal of the limitation or difficult and costly alteration of the soil or special design or intensive maintenance.

V-Very Poor: Soils have one or more features so unfavorable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

## Soil Suitability Subclasses

The subclasses indicate the basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering properties and recreation uses. The properties and their respective codes are provided in Table 8. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

Example: "Pai" for permanent buildings with basements - indicates a soil rating of poor (P) due to subgrade properties (a) and flooding hazard (i).

Table 7. Land Classification Standards for Irrigation Suitability.

| Land Characteristics | Subclass | Class 1 - Very Good | Class 2 - Good | Class 3 - Fair | Class 4 - Poor |
|---|---|---|---|---|---|
| **SOILS** | S | | | | |
| Texture | | | | | |
| very coarse textured | v | Fine sandy loams to | Loamy fine sand to | Sand to permeable | Gravel to |
| very fine textured | h | clay loams | light clay | clay | clay |
| Water holding capacity | | | | | |
| low available moisture capacity | q | 40 to 60 sat. %<br>>15cm storage in 1.2m<br><10cm/hr. hydraulic cond. | 35 to 65 sat. %<br>>12.5cm storage in 1.2m<br><12.5cm/hr. hydraulic cond. | 25 to 75 sat. %<br>>7.5cm storage in 1.2m<br><17.5cm/hr. hydraulic cond. | <25 or >75 sat. %<br><7.5cm storage in 1.2m<br>>17.5cm/hr. hydraulic cond. |
| Geological Deposit | | | | | |
| shallow deposit over sand or gravel | k | .9m or more of fine sandy loam or heavier | .6m or more of fine sandy loam or heavier, or .75m plus of loamy fine sand or sandy loam | .5m or more of sandy loam or heavier, or .6m plus of loamy sand | <.5m of sandy loam or heavier, or .6m of loamy sand or sand |
| shallow deposit over impervious substrata | b | >3m of permeable material | >2m of permeable material | >1m of permeable material | <1m of permeable material |
| Salinity and Alkalinity[1,2] | a | <4 ms/cm in 0-.6m<br><8 ms/cm below .6m<br><6 S.A.R. | <4 ms/cm in 0-.6m<br><12 ms/cm below .6m<br><8 S.A.R. | <8 ms/cm in 0-.6m<br><15 ms/cm below .6m<br><12 S.A.R. | >8 ms/cm in 0-.6m<br>>15 ms/cm below .6m<br>>12 S.A.R. |
| **EXTERNAL FEATURES** | | | | | |
| Stones - rock clearing | r | None to light clearing | Light to medium clearing | Light to heavy clearing | Excessively stony |
| Topography | T | | | | |
| Slope | g | <1% and 0.1% in general gradient (0-3% slope) | <3% in general gradient (3-5% slope) | <5% in general gradient (5-10% slope) | >5% in general* gradient (>10% slope)** |
| excess gradient | | | | | |
| **DRAINAGE** | D | | | | |
| restricted outlet | | No problem anticipated | Moderate drainage problem anticipated but may be improved at relatively low cost | Moderate to severe drainage problem anticipated but may be improved by expensive but feasible measures | Drainage improvement not considered feasible |
| water table | | below 2.4m most of year | could be above 1.5m for a short period, then recedes to 2.4m or lower | within 1.5m most of year | within 1m most of year |

* Criteria for gravity (flood) irrigation requirements.

** Estimated adjustments to slope criteria for overhead or sprinkler type irrigation methods.

1 If sufficient gypsum is present in the soil, the S.A.R. may be lowered by leaching the soil (a very slow process), and the hydraulic conductivity may then improve.

2 The degree of salinity may vary widely within short distances, and there may be no clear indication of the area occupied by each salinity class. Unless a very detailed mapping and sampling program is carried out, it is impossible to estimate the acreage occupied by each salinity class.

TABLE 8

Codes utilized to identify limitations in evaluating soil suitability for selected Engineering and Recreational Uses

| | |
|---|---|
| a | subgrade properties |
| b | thickness of topsoil |
| c | coarse fragments on surface |
| d | depth to bedrock |
| e | erosion or erodibility |
| f | susceptibility to frost hazard |
| g | contamination hazard of groundwater |
| h | depth to seasonal water table |
| i | flooding or inundation |
| j | thickness of slowly permeable material |
| k | permeability or hydraulic conductivity |
| l | shrink-swell properties |
| m | moisture limitations or deficit |
| n | salinity or sulphate hazard |
| o | organic matter |
| p | stoniness |
| q | depth to sand or gravel |
| r | rockiness |
| s | surface texture |
| t | topographic slope class |
| u | moist consistence |
| w | wetness or soil drainage class |
| z | permafrost |

## Guides for Assessing Soil Suitability for Engineering Uses

The assessment of soil suitability for ten engineering related land uses are based on the Guidelines as reported by Coen et al 1977, and U.S.D.A. 1971. In assessing soil suitability for various engineering uses, the degree of suitability was determined by the most restrictive or most severe rating assigned to any one of the listed soil properties. For example, if the suitability was "Good" for all but one soil property which was estimated to be "Very Poor", then the overall rating of the soil for that selected use was "Very Poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be cumulative in their effect for a particular use. Judgement was required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This was left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

Engineering descriptions and estimated properties significant to engineering for all soils are provided in Table 9. These data, in addition to information contained in other sections of the report have been used to rate the soils according to their suitability for ten selected engineering uses in Table 10. When using these interpretations, consideration must be given to the following assumptions:

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management as specified in the preamble to each of the Guideline Tables referenced.

2. Soil ratings do not include site factors such as nearness to towns and highways, water supply, aesthetic values, etc.

3. Soil ratings are based on natural, undisturbed soil.

4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1.5 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.

5. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify the soil limitations. The use of soils rated as poor depends on the nature of the limitations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.

6. Interpretations of map units do not eliminate the need for onsite evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an

area where a development is planned. The need for or importance of on-site studies depends on the use to be made of the soil and the kinds of soil and soil problems involved.

## 4.5 SOIL SUITABILITY FOR SELECTED RECREATION USES

This section provides interpretations of the soil suitability for recreational development. All types of soil can be used for recreational activities of some kind.

Soils and their properties determine to a large degree, the type and location of recreational facilities. Wet soils are not suitable for campsites, roads, playgrounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is contemplated. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by other basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The suitability of the various soil series and phases for selected recreation uses is shown in Table 11 according to four classes, Good, Fair, Poor and Very Poor defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols are provided in Table 8.

The ratings were judged according to guidelines for various recreation uses as presented in the report by Coen et al 1977.

Table 9. Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses

| Map Symbol | Soil Series Name | Depth (cm) | Textural Classification | | | % Passing Sieve | | | Disturbed Hydraulic Conductivity (cm/hr) | Reaction (pH) | Electrical Conductivity (mS/cm) | Sulphate Hazard | Shrink-Swell Potential | Depth to Seasonal Water Table (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | USDA | Unified | AASHO | No. 10 2.0 mm | No. 40 0.42 mm | No. 200 0.074 mm | | | | | | |
| CME | Cranmer | 0-25 | L-CL | OL | - | 100 | 100 | 95-100 | 1.5-5 | 7.4-7.8 | <1.6 | low | mod. | <1 |
| | | 25-100+ | SICL | CL | A-7-6 | 100 | 100 | 95-100 | .5-5 | 7.8-8.2 | <1.6 | low | mod. | |
| CMR | Cameron | 0-25 | L | OL | - | 100 | 100 | 75-85 | 1.5-5 | 7.0-7.8 | <0.5 | low | low | |
| | | 25-100 | L | ML | A-4 | 100 | 100 | 75-85 | 1.5-5 | 7.8-8.2 | <1.6 | low | low | >2 |
| CRM | Cromer | 0-30 | C | OH | - | 100 | 100 | 100 | .15-.5 | 7.4-7.8 | <1.6 | low | high | seasonal |
| | | 30-100+ | C | CH | A-7-6 | 100 | 100 | 100 | <.15 | 7.8-8.2 | <4 | low-mod. | high | at surface |
| CRM | Cromer | 0-30 | C | OH | - | 100 | 100 | 100 | .15-.5 | 7.4-7.8 | >4 | high | high | seasonal |
| e,t,u | saline | 30-100+ | C | CH | A-7-6 | 100 | 100 | 100 | <.15 | 7.8-8.2 | >4 | high | high | at surface |
| CRM! | Cromer | 0-30 | C | OH | - | 100 | 100 | 100 | .15-.5 | 7.4-7.8 | <1.6 | low | high | seasonal |
| e,t,u | sandy | 30-90 | C | CH | A-7-6 | 100 | 100 | 100 | <.15 | 7.8-8.2 | <4 | low-mod. | high | at |
| | substrate | 90-100+ | FS-LS | SP | A-3,A-2-4 | 100 | 85-95 | 5-35 | 5-15 | 7.8-8.2 | <4 | low-mod. | neg. | surface |
| CRM! | Cromer | 0-30 | C | OH | - | 100 | 100 | 100 | .15-5 | 7.4-7.8 | >4 | high | high | seasonal |
| ee, | saline | 30-90 | C | CH | A-7-6 | 100 | 100 | 100 | <.15 | 7.8-8.2 | >4 | high | high | at |
| e,t,u | | 90-100+ | FS-LS | SP | A-3,A-2-4 | 100 | 85-95 | 5-35 | 5-15 | 7.8-8.2 | >4 | high | neg. | surface |
| EBL | Emblem | 0-35 | L-CL | OL to OH | - | 100 | 100 | 100 | 1.5-5 | 7.6-8.2 | <1.6 | low | mod. | seasonal |
| | | 35-100+ | L | ML | A-4 | 100 | 100 | 85-95 | 1.5-5 | 7.8-8.2 | <4 | low-mod. | mod. | at surface |
| EBL | Emblem | 0-35 | L-CL | OL to OH | - | 100 | 100 | 100 | 1.5-5 | 7.8-8.2 | >4 | severe | mod. | seasonal |
| e,u | saline | 35-100+ | L | ML | A-4 | 100 | 100 | 85-95 | 1.5-5 | 7.8-8.2 | >4 | severe | mod. | at surface |
| GDC | Grande | 0-25 | LFS | SM | - | 100 | 100 | 25-35 | 15-50 | 5.0-6.2 | 0.5 | low | neg. | |
| | Clairiere | 25-100+ | FS | SP | A-3 | 100 | 95-100 | 5-10 | 15-50 | 6.2-6.5 | 0.5 | low | neg. | >2 |
| HRT | Hartney | 0-30 | L | OL | - | 100 | 100 | 75-85 | 1.5-5 | 7.6-8.2 | <1.6 | low | low | <1 |
| | | 30-100+ | L-SIL | ML to CL | A-4,A-6 | 100 | 100 | 75-85 | 1.5-5 | 7.8-8.2 | <4 | low-mod. | low | |
| HRY | Hartney | 0-30 | L | OL | - | 100 | 100 | 75-85 | 1.5-5 | 7.8-8.2 | >4 | high | low | <1 |
| e,t,u | saline | 30-100+ | SIL | ML to CL | A-4,A-6 | 100 | 100 | 75-85 | 1.5-5 | 7.8-8.2 | >4 | high | low | |
| LYT | Lyleton | 0-35 | LVFS-VFSL | OL | - | 100 | 100 | 50-70 | 1.5-5 | 7.0-7.4 | <.5 | low | low | >2 |
| | | 35-100+ | LVFS-VFS | ML | A-4 | 100 | 100 | 50-70 | 1.5-5 | 7.3-8.0 | <1.6 | low | neg. | |
| MHC | Marsh | 0-15 | peaty | Pt | - | - | - | - | - | 7.5-8.2 | <2 | low-mod. | - | above |
| | Complex | 15-100 | var. | var. | var. | - | - | - | - | 7.5-8.2 | <6 | low-mod. | var. | surface |
| MMV | Martinville | 0-45 | L | OL | - | 100 | 100 | 50-60 | 1.5-5 | 7.4-7.8 | <1.6 | low | low | seasonal |
| | | 45-90 | L | ML | A-4 | 100 | 100 | 50-60 | 1.5-5 | 7.8-8.2 | <4 | low-mod. | low | at |
| | | 90-100+ | FS-LFS | SP | A-2-4 | 100 | 100 | 10-20 | 5-15 | 7.5-8.2 | <4 | low-mod. | neg. | surface |
| MMV | Martinville | 0-45 | L | OL | - | 100 | 100 | 50-60 | 1.5-5 | 7.4-7.8 | >4 | high | low | seasonal |
| e,t,u | saline | 45-90 | L | ML | A-4 | 100 | 100 | 50-60 | 1.5-5 | 7.8-8.2 | >4 | high | low | at |
| | | 90-100+ | FS-LFS | SP | A-2-4 | 100 | 100 | 10-20 | 5-15 | 7.5-8.2 | >4 | high | neg. | surface |
| ORL | Oak Lake | 0-50 | LFS | SM | - | 100 | 100 | 25-35 | 5-15 | 7.6-8.0 | <1.6 | low | neg. | seasonal |
| | | 50-100+ | FS | SP | A-3 | 100 | 95-100 | 5-10 | 5-15 | 7.8-8.2 | <4 | low-mod. | neg. | at surface |
| PAR | Plum Lake | 0-40 | LVFS | OL | - | 100 | 100 | 50-60 | 5-15 | 7.6-8.0 | <1.6 | low | low | seasonal |
| | | 40-100+ | VFS | SM | A-2-4 | 100 | 100 | 25-35 | 5-15 | 7.8-8.2 | <4 | low-mod. | neg. | at surface |
| PPT | Pipestone | 0-40 | C | OH | - | 100 | 100 | 100 | .15-.5 | 7.0-7.6 | <1.6 | low | high | <1 |
| | | 40-100+ | C | CH | A-7-6 | 100 | 100 | 100 | <.15 | 7.8-8.2 | <4 | low-mod. | high | |
| PPT | Pipestone | 0-40 | C | OH | - | 100 | 100 | 100 | .15-.5 | 7.0-7.6 | >4 | high | high | <1 |
| e,t,u | saline | 40-100+ | C | CH | A-7-6 | 100 | 100 | 100 | <.15 | 7.8-8.2 | >4 | high | high | |

Table 9 . Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses

| Map Symbol | Soil Series Name | Depth (cm) | Textural Classification | | | % Passing Sieve | | | Disturbed Hydraulic Conductivity (cm/hr) | Reaction (pH) | Electrical Conductivity (mS/cm) | Sulphate Hazard | Shrink-Swell Potential | Depth to Seasonal Water Table (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | USDA | Unified | AASHO | No. 10 2.0 mm | No. 40 0.42 mm | No. 200 0.074 mm | | | | | | |
| PPT1 | Pipestone sandy substrate | 0-40 | C | OH | - | 100 | 100 | 100 | .15-.5 | 7.0-7.6 | <4 | low | high | <1 |
| | | 40-90 | C | CH | A-7-6 | 100 | 100 | 100 | <.15 | 7.8-8.2 | <4 | low-mod. | high | |
| | | 90-100+ | FS-LS | SP | A-3,A-2-4 | 100 | 85-95 | 5-15 | 5-15 | 7.8-8.2 | <4 | low-mod. | neg. | |
| PPT1 s,t,u | Pipestone ss, saline | 0-40 | C | OH | - | 100 | 100 | 100 | .15-.5 | 7.0-7.6 | >4 | high | high | <1 |
| | | 40-90 | C | CH | A-7-6 | 100 | 100 | 100 | <.15 | 7.8-8.2 | >4 | high | high | |
| | | 90-100+ | FS-LS | SP | A-3,A-2-4 | 100 | 85-95 | 5-15 | 5-15 | 7.8-8.2 | >4 | high | neg. | |
| RTO | Ralston | 0-25 | LFS | SM | - | 100 | 100 | 25-35 | 15-50 | 6.5-7.0 | <.5 | low | neg. | <1 |
| | | 25-100+ | FS | SP | A-3 | 100 | 95-100 | 5-10 | 15-50 | 7.0-7.4 | <.5 | low | neg. | |
| SCH | Scarth | 0-20 | LFS | SM to SP | - | 100 | 85-95 | 5-35 | 5-15 | 7.4-7.8 | <.5 | low | neg. | >2 |
| | | 20-100 | FS-LS | SM to SP | A-3,A-2-4 | 100 | 85-95 | 3-15 | 5-15 | 7.8-8.2 | <1.6 | low | neg. | |
| SOU | Souris | 0-35 | LFS | SM | - | 100 | 100 | 25-35 | 5-15 | 7.4-7.8 | <1.6 | low | neg. | <1 |
| | | 35-100+ | FS | SP | A-3 | 100 | 95-100 | 5-10 | 5-15 | 7.8-8.2 | <4 | low-mod. | neg. | |
| SOU s, | Souris saline | 0-35 | LFS | SM | - | 100 | 100 | 25-35 | 5-15 | 7.8-8.2 | >4 | high | neg. | <1 |
| | | 35-100+ | FS | SP | A-3 | 100 | 95-100 | 5-10 | 5-15 | 7.8-8.2 | >4 | high | neg. | |
| STU | Stanton | 0-60 | LFS | SM | - | 100 | 100 | 25-35 | 5-15 | 6.5-7.0 | <.5 | low | neg. | >2 |
| | | 60-100+ | FS | SP | A-3 | 100 | 95-100 | 5-10 | 5-15 | 7.6-8.2 | <.5 | low | neg. | |
| SWI | Switzer | 0-35 | LVFS-VFSL | OL | - | 100 | 100 | 75-90 | 1.5-5 | 7.6-8.2 | <1.6 | low | low | <1 |
| | | 35-100+ | LVFS-VFS | ML | A-4 | 100 | 100 | 75-85 | 1.5-5 | 7.6-8.2 | <4 | low-mod. | neg. | |
| SWI s, | Switzer saline | 0-25 | LVFS-VFSL | OL | - | 100 | 100 | 75-90 | 1.5-5 | 7.8-8.2 | >4 | high | low | <1 |
| | | 25-100+ | LVFS-VFS | ML | A-4 | 100 | 100 | 5-85 | 1.5-5 | 7.8-8.2 | >4 | high | neg. | |

* Permeability of horizons or layers is expressed in cm/hr

** Sulfate Hazard - relative degree of sulfate attack on concrete based on criteria established by U.S. Bureau of Reclamation.

| | | | |
|---|---|---|---|
| very rapid | >50 cm/hr | moderate | 1.5-5 cm/hr |
| rapid | 15-50 cm/hr | moderately slow | 0.5-1.5 cm/hr |
| moderately rapid | 5-15 cm/hr | slow | .15-0.5 cm/hr |
| | | very slow | <.15 |

Abbreviations:
mod. - moderate
neg. - negligible

TABLE. 10 SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

| Map Symbol and Phase | Soil Name | Top Soil | Sand & Gravel | Road Fill | Permanent Bldgs. With Basements | Local Roads and Streets | Sanitary Trench | Landfill Area | Cover Material | Sewage Lagoons | Septic Fields |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CME | Cranmer | Fs | Va | Faw | Pw | Faw | Pw | Fw | Fs | Fk | Phk |
| CMR | Cameron | G | Va | Fa | Fa | Fa | G | G | G | Fa | Fk |
| CMR | Cameron | G | Va | Fa | Fa | Fa | G | G | G | Fa | Fk |
| CMR /1cxx | Cameron | Fb | Va | Fa | Fa | Fa | G | G | G | Fat | Fk |
| CRM | Cromer | Ps | Va | Paw | Vh | Paw | Vh | Vh | Psw | G | Vkh |
| CRM /xxxs | Cromer | Psn | Va | Paw | Vh | Paw | Vh | Vh | Psw | G | Vkh |
| CRM /xxxt | Cromer | Vn | Va | Paw | Vh | Paw | Vh | Vh | Psw | G | Vkh |
| CRMp /xxxt | Cromer | Vn | Va | Vwa | Vh | Paw | Vh | Vh | Psw | G | Vkh |
| CRM /xxxu | Cromer | Vn | Va | Paw | Vh | Paw | Vh | Vh | Psw | G | Vkh |
| CRM1 | Cromer | Ps | Pq | Paw | Vh | Paw | Vh | Vh | Psw | Pj | Vh |
| CRM1 /xxxs | Cromer | Psn | Pq | Paw | Vh | Paw | Vh | Vh | Psw | Pj | Vh |
| CRM1 /xxxt | Cromer | Vn | Pq | Paw | Vh | Paw | Vh | Vh | Psw | Pj | Vh |
| CRM1 /xxxu | Cromer | Vn | Pq | Paw | Vh | Paw | Vh | Vh | Psw | Pj | Vh |
| EBL | Emblem | G | Va | Pw | Vw | Pw | Vw | Pw | Pw | Vh | Vh |
| EBL /xxxs | Emblem | Pn | Va | Pw | Vw | Pw | Vw | Pw | Pw | Vh | Vh |
| EBL /xxxu | Emblem | Vn | Va | Vw | Vh | Vi | Vh | Vh | Pw | Vh | Vh |
| GDC /xcxx | Grande-Clairiere | Vsb | G | G | G | G | Vk | Vk | Vs | Vk | Gg |
| GDC /xdxx | Grande-Clairiere | Vsb | G | G | G | G | Vh | Vk | Vs | Vk | Gg |
| GDC /xexx | Grande-Clairiere | Vsb | G | G | Ft | Ft | Vk | Vk | Vs | Vkt | Ftg |
| GDC /xfxx | Grande-Clairiere | Vbt | G | Ft | Pt | Pt | Vk | Vk | Vs | Vkt | Ptg |
| HRY | Hartney | G | Va | Faw | Pw | Faw | Pw | Fw | G | Fak | Ph |
| HRY /xcxu | Hartney | Vn | Va | Faw | Fa | Faw | Pw | Fw | Fs | Fa | Ph |
| LYT | Lyleton | G | Va | Fa | Fa | Fa | Pk | Pk | Fs | Pk | Fk |
| LYT /xcxx | Lyleton | G | Va | Fa | Fa | Fa | Pk | Pk | Fs | Pk | Fk |
| LYT /0cxx | Lyleton | G | Va | Fa | Fa | Fa | Pk | Pk | Fs | Pk | Fk |
| LYT /1cxx | Lyleton | Fb | Va | Fa | Fa | Fa | Pk | Pk | Fs | Pk | Fk |
| LYT /xdxx | Lyleton | Ft | Va | Fa | Fa | Fa | Pk | Fs | Fs | Pk | Fk |
| MHC | Marsh Complex | Vw | Va | Vw | Vw | Vw | Vw | Vw | Vw | Vh | Vh |
| MNV | Martinville | Fs | Va | Paw | Vh | Pwi | Vh | Vh | Pw | Vh | Vh |
| MNV /xxxs | Martinville | Pn | Va | Paw | Vh | Pwi | Vh | Vh | Pw | Vh | Vh |

TABLE.10 SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

| Map Symbol and Phase | Soil Name | Top Soil | Sand & Gravel | Road Fill | Permanent Bldgs. With Basements | Local Roads and Streets | Sanitary Trench | Landfill Area | Cover Material | Sewage Lagoons | Septic Fields |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MNV /xxxt | Martinville | Vn | Va | Paw | Vh | Pwi | Vh | Vh | Pw | Vh | Vh |
| MNV /xxxu | Martinville | Vn | Va | Paw | Vh | Pwi | Vh | Vh | Pw | Vh | Vh |
| OKL | Oak Lake | Ps | Pa | Paw | Vw | Pwi | Vh | Vh | Pw | Vkh | Vh |
| OKL /xxxs | Oak Lake | Pn | Pa | Paw | Vh | Pwi | Vh | Vh | Pw | Vkh | Vh |
| OKL /xxxt | Oak Lake | Vn | Pa | Paw | Vh | Pwi | Vh | Vh | Pw | Vkh | Vh |
| OKL /xxxu | Oak Lake | Vn | Pa | Paw | Vh | Pwi | Vh | Vh | Pw | Vkh | Vh |
| OKLp /xxxt | Oak Lake | Vn | Pa | Paw | Vh | Vw | Vh | Vh | Vw | Vkh | Vh |
| PAK | Plum Lake | Ps | Pa | Paw | Vw | Pwi | Vh | Vh | Pw | Vh | Vh |
| PPT /xxxs | Pipestone | Psn | Va | Pa | Paw | Pa | Pw | Fw | Ps | G | Pk |
| PPT /xxxt | Pipestone | Vn | Va | Pa | Paw | Pa | Pw | Fw | Ps | G | Pk |
| PPT1 | Pipestone | Ps | Pq | Faw | Pw | Pa | Pw | Vk | Ps | Pj | Pk |
| PPT1 /xxxs | Pipestone | Psn | Pq | Faw | Pw | Pa | Pw | Vk | Ps | Pj | Pk |
| PPT1 /xxxu | Pipestone | Vn | Pg | Faw | Pw | Pa | Pw | Vk | Ps | Pj | Pk |
| RTO | Ralston | Fs | Fa | Fw | Pw | Fw | Pkw | Vk | Vs | Vk | Fh |
| SCH /1dxx | Scarth | Psb | Fa | G | G | G | Vk | Vk | Vs | Vk | Gg |
| SOU | Souris | Ps | Pa | Fw | Pw | Fw | Vsk | Vk | Vs | Vk | Ph |
| SOU /1xxx | Souris | Ps | Pa | Fw | Pw | Fw | Vsk | Vk | Vs | Vk | Ph |
| SOU /0xxx | Souris | Ps | Pa | Fw | Pw | Fw | Vsk | Vk | Vs | Vk | Ph |
| SOU /xxxs | Souris | Psn | Fa | Fw | Pw | Fw | Vk | Vk | Vs | Vk | Fhg |
| SOU /xcxx | Souris | Psb | Fa | Fw | Pw | Fw | Vk | Vk | Vs | Vk | Fhg |
| SOU /xcxs | Souris | Psb | Fa | Fw | Pw | Fw | Vk | Vk | Vs | Vk | Fhg |
| STU | Stanton | Ps | Fa | G | G | G | Vs | Vk | Vs | Vk | Gg |
| STU /1xxx | Stanton | Psb | Fa | G | G | G | Vk | Vk | Vs | Vk | Gg |
| STU /0xxx | Stanton | Ps | Fa | G | G | G | Vk | Vk | Vs | Vk | Gg |
| STU /xcxx | Stanton | Ps | Fa | G | G | G | Vk | Vk | Vs | Vk | Gg |
| STU /1cxx | Stanton | Psb | Fa | G | G | G | Vs | Vk | Vs | Vk | Gg |
| STU /1dxx | Stanton | Psb | Fa | G | G | G | Vk | Vk | Vs | Vk | Gg |
| SWZ | Switzer | G | Va | Fw | Pw | Faw | Pw | Fw | Fs | Pk | Ph |
| SWZ /xxxs | Switzer | Pn | Va | Fw | Pw | Faw | Pw | Fw | Fs | Pk | Ph |
| WWS | Wawanesa | Fb | Pq | Fw | Pw | Faw | Vk | Vk | Pw | Vk | Fk |
| WWS /xxxs | Wawanesa | Pn | Pq | Fw | Pw | Faw | Vk | Vk | Pw | Vk | Fk |
| WWS /xxxt | Wawanesa | Vn | Pq | Fw | Pw | Faw | Vk | Vk | Pw | Vk | Ph |
| WWS /xxxu | Wawanesa | Vn | Pq | Fw | Pw | Faw | Vk | Vk | Pw | Vk | Ph |
| ZZZ | Water | | | | | | | | | | |

TABLE. 11 SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

| Map Symbol and Phase | Soil Name | Play Ground | Picnic Area | Camp Area | Path And Trails | Permanent Bldgs. Without Basements |
|---|---|---|---|---|---|---|
| CME | Cranmer | Fsw | Fsw | Fsw | Fsw | Faw |
| CMR | Cameron | Fs | Fs | Fs | Fs | Fa |
| CMR | Cameron | Fs | Fs | Fs | Fs | Fa |
| CMR /1cxx | Cameron | Fst | Fs | Fs | Fs | Fa |
| CRM | Cromer | Pkw | Psw | Psw | Psw | Vh |
| CRM /xxxs | Cromer | Pkw | Psw | Psw | Psw | Vh |
| CRM /xxxt | Cromer | Pkw | Psw | Psw | Psw | Vh |
| CRMp /xxxt | Cromer | Vs | Psw | Psw | Psw | Vh |
| CRM /xxxu | Cromer | Psw | Psw | Psw | Psw | Vh |
| CRM1 | Cromer | Psw | Psw | Psw | Psw | Vh |
| CRM1 /xxxs | Cromer | Psw | Psw | Psw | Psw | Vh |
| CRM1 /xxxt | Cromer | Psw | Psw | Psw | Psw | Vh |
| CRM1 /xxxu | Cromer | Psw | Psw | Psw | Psw | Vh |
| EBL | Emblem | Pw | Pw | Pw | Pw | Pw |
| EBL /xxxs | Emblem | Pwn | Pwn | Pwn | Pw | Pw |
| EBL /xxxu | Emblem | Pw | Pw | Pw | Psw | Vh |
| GDC /xcxx | Grande-Clairiere | Vs | Vs | Vs | Vs | G |
| GDC /xdxx | Grande-Clairiere | Vs | Vs | Vs | Ps | G |
| GDC /xexx | Grande-Clairiere | Vst | Vs | Vs | Ps | Ft |
| GDC /xfxx | Grande-Clairiere | Vst | Vs | Vs | Ps | Pt |
| HRY | Hartney | Fsw | Fsw | Fsw | Fsw | Faw |
| HRY /xcxu | Hartney | Fsw | Fs | Ps | Fs | Fa |
| LYT | Lyleton | G | G | G | G | Fa |
| LYT /xcxx | Lyleton | Ft | G | G | G | Fa |
| LYT /0cxx | Lyleton | Ft | G | G | G | Fa |
| LYT /1cxx | Lyleton | Ft | G | G | G | Fa |
| LYT /xdxx | Lyleton | Pt | Ft | G | G | Fa |
| MHC | Marsh Complex | Vw | Vw | Vw | Vw | Vw |
| MNV | Martinville | Pw | Pw | Pw | Pw | Vh |
| MNV /xxxs | Martinville | Pw | Pw | Pw | Pw | Vh |
| MNV /xxxt | Martinville | Pw | Pw | Pw | Pw | Vh |
| MNV /xxxu | Martinville | Pw | Pw | Pw | Pw | Vh |
| OKL | Oak Lake | Pw | Pw | Pw | Pw | Vh |
| OKL /xxxs | Oak Lake | Pw | Pw | Pw | Pw | Vh |
| OKL /xxxt | Oak Lake | Pw | Pw | Pw | Pw | Vh |
| OKL /xxxu | Oak Lake | Pw | Pw | Pw | Pw | Vh |
| OKLp /xxxt | Oak Lake | Vsw | Vsw | Vsw | Pw | Vh |
| PAK | Plum Lake | Pw | Pw | Pw | Pw | Vh |
| PPT /xxxs | Pipestone | Ps | Ps | Psw | Ps | Paw |
| PPT /xxxt | Pipestone | Ps | Ps | Psw | Ps | Paw |

TABLE. 11 SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

| Map Symbol and Phase | Soil Name | Play Ground | Picnic Area | Camp Area | Path And Trails | Permanent Bldgs. Without Basements |
|---|---|---|---|---|---|---|
| PPT1 | Pipestone | Ps | Ps | Psw | Ps | Paw |
| PPT1 /xxxs | Pipestone | Ps | Ps | Psw | Ps | Paw |
| PPT1 /xxxu | Pipestone | Ps | Ps | Psw | Ps | Paw |
| RTO | Ralston | Vs | Vs | Vs | Vs | Fw |
| SCH /1dxx | Scarth | Pst | Fs | Fs | G | G |
| SOU | Souris | Fsw | Fsw | Fsw | Fw | Fw |
| SOU /1xxx | Souris | Fsw | Fsw | Fsw | Fw | Fw |
| SOU /0xxx | Souris | Fsw | Fsw | Fsw | Fw | Fw |
| SOU /xxxs | Souris | Fsw | Fsw | Fsw | Fw | Fw |
| SOU /xcxx | Souris | Fst | Fsw | Fsw | Fw | Fw |
| SOU /xcxs | Souris | Fst | Fsw | Fsw | Fw | Fw |
| STU | Stanton | Fsm | Fsm | Fs | G | G |
| STU /1xxx | Stanton | Ps | Fs | Fs | G | G |
| STU /0xxx | Stanton | Ps | Fs | Fs | G | G |
| STU /xcxx | Stanton | Ps | Fs | Fs | G | G |
| STU /1cxx | Stanton | Ps | Fsm | Fs | G | G |
| STU /1dxx | Stanton | Pst | Fs | Fs | G | G |
| SWZ | Switzer | Fw | Fw | Fw | Fw | Fw |
| SWZ /xxxs | Switzer | Pwn | Pwn | Pwn | Fwn | Fw |
| WWS | Wawanesa | Fs | Fsw | Fsw | Fw | Fw |
| WWS /xxxs | Wawanesa | Fs | Fsw | Fsw | Fw | Fw |
| WWS /xxxt | Wawanesa | Fs | Fsw | Fsw | Fw | Fw |
| WWS /xxxu | Wawanesa | Fs | Psw | Fsw | Fw | Fw |
| ZZZ | Water | | | | | |

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## Appendix A

## GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7. See pH and Reaction, soil.

Alkaline soil - A soil having a pH greater than 7. See Reaction, soil.

Alluvium - A general term for all deposits of rivers and streams.

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occuring under similar climatic conditions but showing different characteristics due to variations in relief and in drainage.

1/3 Atmosphere Moisture - The moisture percentage on dry weight basis of a soil sample that has been air dried, screened, saturated and subjected to a soil moisture tension of 345 cm of water through a permeable membrane for a period of 48 hours. It approximates the soil moisture retention capacity.

Available nutrient - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Available soil moisture - The portion of water in a soil that can be readily absorbed by plant roots: generally considered to be that water held in the soil up to approximately 15 atmospheres pressure.

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals.

Bedrock - The solid rock that underlies soil and regolith or that is exposed at the surface.

Boulders - Stones which are larger than 60 cm in diameter.

Bulk density - The weight of oven dry soil (105 degrees C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

Buried soil - Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in

the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

| | |
|---|---|
| noncalcareous | <1% |
| weakly calcareous | 1-5% |
| moderately calcareous | 6-15% |
| strongly calcareous | 16-25% |
| v. strongly calcareous | 26-40% |
| extremely calcareous | >40% |

Capillary fringe - A zone of essentially saturated soil just above the water table. The size distribution of the pores determines the extent and degree of the capillary fringe.

Carbon-nitrogen ratio (C/N ratio) - The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.

Cation Exchange Capacity (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter: usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

Cobbles - Rock fragments 8 to 25 cm in diameter.

Color - Soil colors are compared with a Munsell color chart. The Munsell system specifies the relative degrees of the three simple variables of color: hue, value and chroma. For example: 10YR 6/4 means a hue of 10YR, a value of 6, and a chroma of 4.

Complex (soil) - A mapping unit used in detailed and reconnaissance soil surveys where two or more soil series that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

Concretions - Hard grains, pellets or nodules from concentration of compounds in the soil that cement soil grains together.

Conductivity, electrical - A physical quantity that measures the readiness with which a medium (irrigation water and soil extracts) transmits electricity. It expresses the concentration of salt in terms of the conductance (reciprocal of the electric resistance in ohms) in milliSiemens per cm (or expressed as deciSiemens per meter - dS/m).

Consistence (soil) - The mutual attraction of the particles in a soil mass, or their resistence to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

Consumptive use factor (CU) - The ratio of consumptive use of water by a crop to potential evapotranspiration. and transpiration. An actively growing crop that completely covers the soil over a large area and that has an ample supply of readily available soil water has a consumptive use factor of 1.0.

Consumptive use of water - The sum of the depths of water transpired by the plants and evaporated from the soil surface and from intercepted precipitation. It may be less or greater than potential evapotranspiration.

Contour - An imaginary line connecting points of equal elevation on the surface of the soil.

Cover - This term generally has one of the following meanings:

1. Vegetation or other material providing protection

2. In forestry, low growing shrubs and herbaceous plants under trees (i.e., ground cover vs. tree cover)

3. Any vegetation producing a protective mat on or just above the soil surface.

Creep (soil) - Slow mass movement of soil and soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and by alternate freezing and thawing.

Decile portion - A one-tenth portion. As used in the soil map symbol A7-B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Delta - A fluvial or glaciofluvial fan shaped deposit at the mouth of a river that empties into a lake or sea.

Deflocculate - To separate or to break up soil aggregates into individual particles by chemical or physical means or both.

Degradation (of soils) - The changing of a soil to a more highly leached and more highly weathered condition, usually accompanied by morphological changes such as the development of an eluviated light colored (Ae) horizon.

Dispersion - Is rated high, moderate or low depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of high indicates that soil aggregates slake readily; a rating of low indicates that aggregates are resistant to dispersion and remain clumped together.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Rapidly drained - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the

control section, and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

Imperfectly drained - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups. These soils generally have mottling below the surface layers and generally have duller colors with depth, generally brownish gray with mottles of yellow and gray.

Poorly drained - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Poorly drained soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. These soils have a wide range in available water

storage capacity, texture, and depth, and are either Gleysolic or Organic.

Dryland farming - The practice of crop production in low rainfall areas without irrigation.

Eluvial horizon - A horizon from which material has been removed in solution or in water suspension.

Eolian - Soil material accumulated through wind action.

Erosion - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes. The ratings of erosion are:

Erosion 1 slightly eroded - soil with a sufficient amount of the A horizon removed that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer.

Erosion 2 moderately eroded - soil with all of the A horizon and a part of the B or other lower lying horizons removed. The plow layer consists mainly of the original horizons below the A or below the original plow layer.

Erosion 3 severely eroded - soils have practically all of the original surface soil removed. The plow layer consists mainly of C horizon material, especially on knolls and steep upper slope positions.

Evapotranspiration - The combined loss of water from a given area, and during a specific period of time, by evaporation from the soil surface and transpiration from plants.

Field Moisture Equivalent - The minimum moisture content at which a drop of water placed on a smoothed surface of the soil will not be absorbed immediately by the soil, but will spread out over the surface and give it a shiny appearance.

Flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.

Fluvial deposits - All sediments past and present, deposited by flowing water, including glaciofluvial deposits.

Frost heave - The raising of the surface caused by ice in the subsoil.

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have

lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Gravel - Rock fragments 2 mm to 7.5 cm in diameter.

Ground Moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till; most till is thought to have accumulated under the ice by lodgment, but some till has been let down from the upper surface of the ice by ablation. Resorting and modification may have taken place to some extent by wave-action of glacial melt waters. The topography is most commonly in the form of undulating plains with gently sloping hills and enclosed depressions.

Groundwater - Water beneath the soil surface, usually under conditions where the voids are completely filled with water (saturation).

Halophytic vegetation - vegetation that grows naturally in soils having a high content of various salts. It usually has fleshy leaves or thorns and resembles desert vegetation.

Horizon (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The form refers to the variation of the boundary plane.

Distinctness -
abrupt - less than 2 cm
clear - 2 to 5 cm
gradual - 5 to 15 cm
diffuse - more than 15 cm

Form -
smooth - nearly plain
wavy - pockets are wider than deep
irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

Humic layer - A layer of highly decomposed organic soil material containing little fibre.

Hydraulic Conductivity - Refers to the effective flow velocity or discharge velocity in soil at unit hydraulic gradient. It is an approximation of the permeability of the soil and is expressed in cm per hour. The classes are described in general or specific terms as:

| | | | |
|---|---|---|---|
| High | >15 | Very rapid | >50 |
| | | Rapid | 15-50 |
| Medium | 0.5-15 | Mod. rapid | 5.0-15 |
| | | Moderate | 1.5-5.0 |
| | | Mod. slow | 0.5-1.5 |
| Low | <0.5 | Slow | 0.15-0.5 |
| | | Very slow | 0.015-0.15 |
| | | Extremely slow | <.015 |

Hydrologic cycle - The conditions through which water naturally passes from the time of precipitation until it is returned to

the atmosphere by evaporation and is again ready to be precipitated.

Hydrophyte - Plants growing in water or dependent upon wet or saturated soil conditions for growth.

Illuvial horizon - A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

Impeded drainage - A condition that hinders the movement of water by gravity through the soils.

Inclusion - Soil type found within a mapping unit that is not extensive enough to be mapped separately or as part of a complex.

Infiltration - The downward entry of water into the soil

Irrigation - The artificial application of water to the soil for the benefit of growing crops.

Irrigation requirement (IR) - Refers to the amount of water exclusive of effective precipitation that is required for crop production.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landforms - See Description of Landforms

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinquish one part of the earth's surface from another part.

Leaching - The removal from the soil of materials in solution.

Liquid limit (upper plastic limit) - The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. The water content at this boundary is defined as that at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 1.25 cm under the impact of 25 blows in a standard liquid limit apparatus.

Lineal shrinkage - This is the decrease in one dimension expressed as a percentage of the original dimension of the soil mass when the moisture content is reduced from a stipulated percentage (usually field moisture equivalent) to the shrinkage limit.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

Mature soil - A soil having well-developed soil horizons produced by the natural processes of soil formation.

Mesophyte - Plants requiring intermediate moisture conditions and are not very resistant to drought.

Microrelief - Small-scale, local differences in relief including mounds, swales or hollows.

Milliequivalent (me) - One-thousandth of an equivalent. An equivalent is the weight in grams of an ion or compound that combines with or replaces one gram of hydrogen. The atomic or formula weight divided by valence.

Mottles - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottles in soils indicate poor aeration and lack of good drainage.

Organic carbon - Carbon derived from plant and animal residues.

Organic matter - The fraction of the soil which consists of plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. It is determined on soils that have been sieved through a 2.0 mm sieve. It is estimated by multiplying the organic carbon by a factor of 1.72.

Outwash - Sediments "washed out" beyond the glacier by flowing water and laid down in thin beds or strata. Particle size may range from boulders to silt.

Ovendry soil - Soil that has been dried at 105 degrees C until it has reached constant weight.

Parent material - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons. See Textural Triangle at end of Glossary.

The particle-size classes for family groupings are as follows:

Fragmental Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

Loamy-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

Clayey-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

Sandy The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm- 25 cm occupy less than 35% by volume.

Loamy The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey. The fine earth contains 35% or more clay by weight and particles 2mm-25 cm occupy less than 35% by volume.

Fine-clayey. A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey. A clayey particle size that has 60% or more clay in the fine earth fraction.

Ped - An individual soil aggregate such as granule, prism or block formed by natural processes (in contrast with a clod which is formed artificially).

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

Percolation - The downward movement of water through soil; specifically, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of 1.0 or less.

Permafrost -

1. Perennially frozen material underlying the solum.

2. A perennially frozen soil horizon.

Permafrost table - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

Permeability - The ease with which water and air pass through the soil to all parts of the profile. See hydraulic conductivity.

pH - The intensity of acidity and alkalinity, expressed as the negative logarithm of the hydrogen ion concentration. A pH of 7 is neutral, lower values indicate acidity and higher values alkalinity (see Reaction, soil).

Phase, soil - A soil phase is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

Plastic Limit - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil.

Plasticity Index - The numerical difference between the liquid and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

Potential evapotranspiration (PE) - The maximum quantity of water capable of being lost as water vapor, in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil - The acidity or alkalinity of a soil. Soil reaction classes are characterized as follows:

| | |
|---|---|
| extremely acid | pH <4.5 |
| very strongly acid | 4.5 to 5.0 |
| strongly acid | 5.1 to 5.5 |
| medium acid | 5.6 to 6.0 |
| slightly acid | 6.1 to 6.5 |
| neutral | 6.6 to 7.3 |
| mildly alkaline | 7.4 to 7.8 |
| mod. alkaline | 7.9 to 8.4 |
| strongly alkaline | 8.5 to 9.0 |
| very strongly alkaline | >9.0 |

Regolith - The unconsolidated mantle of weathered rock and soil material on the earth's surface.

Relief - The elevation of inequalities of the land surface when considered collectively.

Runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

Saline Soil - A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millisiemens/cm (ms/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5. Approximate limits of salinity classes are:

| | |
|---|---|
| non-saline | 0 to 4 ms/cm |
| weakly saline | 4 to 8 mS/cm |
| mod. saline | 8 to 15 ms/cm |
| strongly saline | >15 ms/cm |

Salinization - The process of accumulation of salts in the soil.

Salt-Affected Soil - Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium or both.

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation Percentage - The moisture percentage of a saturated soil paste, expressed on an oven dry weight basis.

Seepage -

1. The escape of water downward through the soil.

2. The emergence of water from the soil along an extensive line of surface in contrast to a spring where water emerges from a local spot.

Series, soil - A category in the Canadian System of Soil Classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, except for surface texture and are formed from a particular type of parent material.

Shrinkage limit - This is the moisture content at which an equilibrium condition of volume change is reached and further reduction in moisture content will not cause a decrease in the volume of the soil mass.

Shrinkage ratio - This is the ratio between the volume change and a corresponding change in moisture content. It equals the apparent specific gravity of the dried soil.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Slickenside - Smoothed surfaces along planes of weakness resulting from the movement of one mass of soil against another in soils dominated by swelling clays.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with other cations in the soil SAR = $Na/((Ca+Mg)/2)^{1/2}$ where the cation concentrations are expressed as milliequivalents per litre.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Stones - Rock fragments greater than 25 cm in diameter.

Stoniness - The percentage of land surface occupied by stones. The classes of stoniness are defined as follows:

Stones 0. Nonstony -- Land having less than 0.01% of surface occupied by stones.

Stones 1. Slightly stony -- Land having 0.01-0.1% of surface occupied by stones. Stones 15-30 cm in diameter, 10-30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. Moderately stony -- Land having 0.1-3% of surface occupied by stones. Stones 15-30 cm in diameter, 2-10 m apart. Stones cause some interference with cultivation.

Stones 3. Very stony -- Land having 3-15% of surface occupied by stones. Stones 15-30 cm in diameter, 1-2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. Exceedingly stony -- Land having 15-50% of surface occupied by stones. Stones 15-30 cm in diameter, 0.7-1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. Excessively stony -- Land having more than 50% of surface occupied by stones. Stones 15-30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation.

Storage Capacity - Refers to the maximum amount of readily available water that can be stored within the rooting zone of a crop in a given soil. For practical irrigation purposes, 50 percent of the total soil water between field capacity and wilting point may be considered as readily available.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers. In stratified materials, a bed is a unit layer distinctly separable from other layers and is one or more cm thick but a lamina is a similar layer less than 1 cm thick.

Structure - The combination or arrangement of primary soil particles into aggregates of secondary soil particles, units or peds, which are separated from each other by surfaces of weakness. Structure is expressed in terms of grade, size class and shape type. Grade refers to the distinctness of aggregate development, and is described as structureless, weak, moderate or strong. Structureless refers to the absence of observable aggregation of definite orderly arrangement; the term amorphous is used if soil is massive or coherent, single-grained if noncoherent. The weak to strong aggregates vary in size and are described by class as fine, medium, coarse, and very coarse depending on the shape types. The shape types refers to the dominant configuration of the aggregates and the way they are accommodated. The general shape types are plate-like, block-like and prism-like. The terms are:

Platy - Having thin, plate-like aggregates with faces mostly horizontal

Prismatic - Having prism-like aggregates with tops and edges, appear plane, level and somewhat angular.

Columnar - Having prism-like aggregates with vertical edges near the top of columns, not sharp.

Granular - Having block-like aggregates that appear as spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of the surrounding peds.

Blocky - Having block-like aggregates with sharp, angular corners

Subangular blocky - Having block-like aggregates with rounded and flattened faces and rounded corners.

By convention an aggregate is described in the order of grade, class and type, e.g. strong, medium, blocky. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Sulfate Hazard - Refers to the relative degree of attack on concrete by soil and water containing various amounts of sulfate ions. It is estimated from electrolyte measurements and salt analysis on selected profiles and soil samples, and by visual examination of free gypsum within the profile during the course of soil investigation.

Swamp - See Description of Landforms

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons. See Texture Triangle at end of Glossary.

The size range of the constituent primary particles are as follows:

| | Diameter (mm) |
|---|---|
| Very coarse sand. . . . | 2.0-1.0 |
| Coarse sand . . . . . | 1.0-0.5 |
| Medium sand . . . . . | 0.5-0.25 |
| Fine sand . . . . . | 0.25-0.10 |
| Very fine sand. . . . | 0.10-0.05 |
| Silt. . . . . | 0.05-0.002 |
| Clay. . . . . | < 0.002 |
| Fine clay . . . . . | < 0.0002 |

Till, glacial - Unstratified glacial deposits consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergency and root penetration.

Topography - Refers to the percent slope and the pattern or frequency of slopes in different directions. A set of 10 slope classes are used to denote the dominant but not necessarily most abundant slopes within a mapping unit.

| Slope Class | Slope Name | Percent slope | Approx. degrees |
|---|---|---|---|
| 1 | level | 0-0.5 | 0 |
| 2 | nearly level | .5-2.5 | .3-1.5 |
| 3 | very gentle | 2-5 | 1-3 |
| 4 | gentle | 6-9 | 3.5-5 |
| 5 | moderate | 10-15 | 6-8.5 |
| 6 | strong | 16-30 | 9-17 |
| 7 | very strong | 31-45 | 17-24 |
| 8 | extreme | 46-70 | 25-35 |
| 9 | steep | 71-100 | 35-45 |
| 10 | very steep | >100 | >45 |

Underground runoff - (or seepage)-Water flowing towards stream channels after infiltration into the ground.

Unified Soil Classification System (engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Urban Land - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.

Variant, soil - A soil whose properties are believed to be sufficiently different from other known soils to justify a new series name, but comprising such a limited geographic area that creation of a new series is not justified.

Varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light colored layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark colored layer of clay laid down in the fall and winter.

Water balance, soil - Is the daily amount of readily available water retained by the soil. The daily soil-water balance is decreased by the amount that the daily consumptive use exceeds the daily rainfall. When daily rainfall exceeds the consumptive use, the daily balance increases by the amount of the difference unless the soil-water balance is at storage capacity, in which case the excess is assumed to be lost by runoff or deep percolation.

Water table - (groundwater surface; free water surface; groundwater elevation) Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

Water-holding capacity - The ability of a soil to hold water against the force of gravity in a freely drained soil.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Xerophyte - Plants capable of surviving extended periods of soil drought.

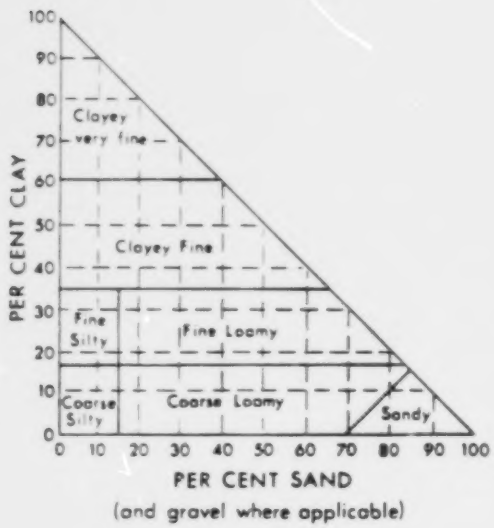
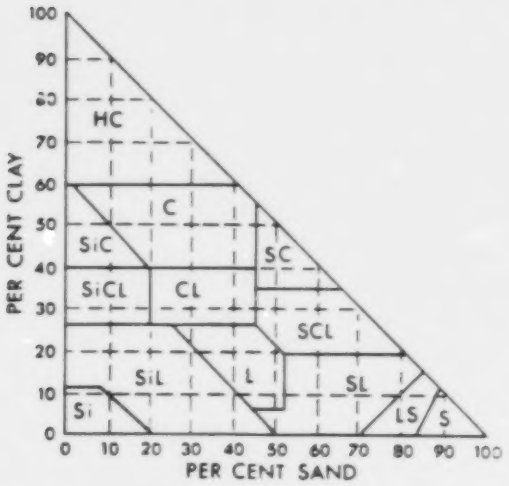



**Figure 7:** Family particle-size classes.




| Texture Group | Class Symbol | Class Name |
|---|---|---|
| Coarse | S | sand |
| | LS | loamy sand |
| Moderately coarse | SL | sandy loam |
| | LVFS | loamy very fine sand |
| Medium | Si | silt |
| | SiL | silt loam |
| | L | loam |
| | VFSL | very fine sandy loam |
| Moderately fine | SCL | sandy clay loam |
| | CL | clay loam |
| | SiCL | silty clay loam |
| Fine | SC | sandy clay |
| | C | clay |
| | SiC | silty clay |
| Very fine | HC | heavy clay |

**Figure 8:** Soil Textural Classes.

## Appendix B

## SOIL HORIZON DESIGNATIONS

### ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

O This is an organic horizon developed mainly from mosses, rushes, and woody materials.

Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.

Om The mesic horizon is the intermediate stage of decompostion with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or humic.

Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

H This is an organic horizon characterized by an accumulation of decomposed organic

matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

**MASTER MINERAL HORIZONS**

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizons.

A This is a mineral horizon or horizons formed at or near the surface in the zone of leaching or removal of materials in solution and suspension or of maximum in situ accumulation of organic matter, or both. Included are:

1. horizons in which organic matter has accumulated as a result of biological activity (Ah);

2. horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of them (Ae);

3. horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);

4. horizons markedly disturbed by cultivation or pasture (Ap).

B This is a mineral horizon or horizons characterized by one or more of the following:

1. an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt,Bf,Bfh,Bhf, and Bh);

2. a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amount of exchangeable Na (Bn);

3. an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm,Bg).

C This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca,Csa,Cg, and C). Marl and diatomaceous earth are considered to be C horizons.

R This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist and that does not meet the requirement of a C horizon. The boundary between the R layer and overlying unconsolidated material is called a lithic contact.

W This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils.

**LOWER-CASE SUFFIXES**

b Buried soil horizon.

c A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, and a layer cemented by calcium carbonate and a duripan are examples.

ca A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10 cm thick, and if it has a $CaCO_3$ equivalent of less than 15 percent it should have at least 5 percent more $CaCO_3$ equivalent than the parent material (IC). If it has more than 15 percent $CaCO_3$ equivalent it should have 1/3 more $CaCO_3$ equivalent than the IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms.

cc Cemented (irreversible) pedogenic concretions.

e A horizon characterized by the eluviation of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).

f A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.002mm) is more than 0.05 and organic C exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of organic C to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. The following horizons are differentiated on the basis of organic carbon content: Bf - 0.5% to 5% organic carbon. Bhf-more than 5% organic carbon.

g A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

Aeg This horizon must meet the definitions of A,e, and g.

Bg These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are lacking; or chromas of 2 or less in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by more promi-

nent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols.

Bfg, Bhfg, Btg, and others. When used in any of these combinations the limits set for f, hf, t, and others must be met.

Bgf The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag. When g is used with C alone, or with C and one of the lower-case suffixes k, ca, s, or sa, it must meet the difinition for C and for the particular suffix.

h A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).

Ah A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.

Ahe An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter-colored Ae.

Bh This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of organic carbon to pyrophosphate-extractable Fe of 20 or more. Generally the color value and chroma are less than 3 when moist.

Bhf Defined under 'f'.

j Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies. For example Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features.

Aej It denotes an eluvial horizon that is thin, discontinuous or slightly discernible.

Btj It is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj. Horizons that are mottled but do not meet the criteria of Bg.

Bfj It is a horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf.

Bntj or Bnj. Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt.

k Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk).

m A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:

1. Evidence of alteration in one of the following forms:

   a) Higher chromas and redder hues than the underlying horizons.

   b) Removal of carbonates, either partially (Bmk) or completely (Bm).

2. Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.

3. Some weatherable minerals.

4. No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

n A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt.

p A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O.

s A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any horizon or combination of horizon and lowercase suffix.

sa A horizon with secondary enrich-

ment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 ms/cm and must exceed that of the C horizon by at least one-third.

t An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc.

Bt A Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:

   a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2mm) the Bt horizon must contain at least 3% more clay, e.g.,Ae 10% clay-Bt minimum 13% clay.

   b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.

   c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g. Ae 50% clay; Bt at least 58% clay.

2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.

3. In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.

4. If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.

5. If a soil shows a lithologic discontinuity between the eluvial

horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

Btj, Btj, and Btg are defined under j and g.

u A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc. must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g. Aeu, Bfu, BCu.

x A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water.

y A horizon affected by cryoturbation as manifested by disrupted and broken horizons,, incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g. Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc.

z A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

## Appendix C

## DESCRIPTION OF LANDFORMS

### C.1 GENETIC MATERIALS

#### Unconsolidated mineral component

The unconsolidated mineral component consists of clastic sediments that may or may not be stratified, but whose particles are not cemented together. They are essentially of glacial or post-glacial origin but include poorly consolidated and weathered bedrock.

Anthropogenic - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.

Colluvial - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement.

They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches).

Eolian - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

These materials have been transported and deposited by wind action.

Fluvial - Sediment generally consisting of gravel and sand with a minor fraction of silt and clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification, but massive, nonsorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. Finer textured Fluvial deposits of modern rivers are termed Alluvium.

Lacustrine - Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action.

These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action.

Marine - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have

accumulated at their margins through shoreline processes such as wave action and longshore drift.

Morainal - Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Saprolite - Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering.

The rock remains in a coherent state, interstitial grain relationships are undisturbed and no downhill movement due to gravity has occurred.

Undifferentiated - A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment.

Volcanic - Unconsolidated pyroclastic sediments. These include volcanic dust, ash, cinders, and pumice.

## Qualifying Descriptors

These have been introduced to qualify the genetic materials and to supply additional information about the mode of formation or depositional environment.

Glacial - Used to qualify nonglacial genetic materials or process modifiers where there is direct evidence that glacier ice exerted a strong but secondary or indirect control upon the mode of origin of the materials or mode of operation of the process. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material or the site of operation of a process.

Glaciofluvial - Fluvial materials showing clear evidence of having been deposited either directly in front of or in contact with glacier ice.

Glaciolacustrine - Lacustrine materials deposited in contact with glacial ice.

Glaciomarine - Materials of glacial origin laid down in a marine environment, as a result of settling from melting, floating ice and ice shelves.

## Organic component

The organic component consists of peat deposits containing >30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick. The classes and their definitions follow.

| | |
|---|---|
| B | Bog |
| N | Fen |
| S | Swamp |

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Fen - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Swamp - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

## C.2 GENETIC MATERIAL MODIFIERS

Material modifiers are used to qualify unconsolidated mineral and organic deposits. Particle-size classes serve to indicate the size, roundness, and sorting of unconsolidated mineral deposits. Fiber classes indicate the degree of decomposition and fiber size of organic materials.

### Particle size classes for unconsolidated mineral materials

Blocky: An accumulation of angular particles greater than 256 mm in size.

Bouldery: An accumulation of rounded particles greater than 256 mm in size.

Clayey: An accumulation of particles where the fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Cobbly: An accumulation of rounded particles having a diameter of 64-256 mm.

Gravelly: An accumulation of rounded particles ranging in size from pebbles to boulders.

Loamy: An accumulation of particles of which fine earth fraction contains 35% or less clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Pebbly: An accumulation of rounded particles having a diameter of 2-64 mm.

Rubbly: An accumulation of angular fragments having a diameter of 2-256 mm.

Sandy: An accumulation of particles of which the fine earth fraction contains more than 70% by weight of fine sand or coarser particles. Particles greater than 2 mm occupy less than 35% by volume.

Silty: An accumulation of particles of which the fine earth fraction contains less than 15% of fine sand or coarser particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.

**Fiber classes for organic materials**

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric: The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

Mesic: Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.

Humic: Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.

Woody: Organic material containing more than 50% of woody fibers.

## C.3 SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

**Consolidated and Unconsolidated mineral surface classes**

Apron - A relatively gentle slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.

Blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.

Fan - A fan-shaped form similar to the segment of a cone and having a perceptible gradient from the apex to the toe.

Hummocky - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35 degrees).

Inclined - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35 degrees). The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Level - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1 degree).

Rolling - A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wave-lake pattern of moderate relief. Slope length is often 1.6 km or

greater and gradients are greater than 5% (3 degrees).

Ridged - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.

Steep - Erosional slopes, greater than 70% (35 degrees), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.

Terraced - Scarp face and the horizontal or gently inclined surface (tread) above it.

Undulating - A very regular sequence of gentle slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3 degrees).

Veneer - Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the material's genesis.

**Organic surface classes**

Blanket - A mantle of organic materials that is thick enough to mask minor irregularities in the underlying unit but still conforms to the general underlying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 cm-1m) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

## Appendix D

## SOIL LEGEND AND INTERPRETATION OF MAP UNIT SYMBOLS

The Soil Series Map Unit is identified by three alphabetic letters, e.g. STU - Stanton series. The phase of the series is identified by an alphabetic or numeric symbol below the soil series symbol. Four possible phases or combinations of phases are presented as follows:

a) first space, numeric, indicates degree of erosion,

b) second space, alphabetic, indicates slope class,

c) third space, numeric, indicates degree of stoniness,

d) fourth space, alphabetic, indicates degree of salinity.

"x" is used to identify the absence of, or the degree of minimal erosion, slope class, stoniness and salinity permitted in the definition of the normal soil.

"p" after the series name indicates the peaty phase.

"1" or other numerals after the series name indicates a variant of the normal series; it may be due to composition difference, textural difference or other property at variance from the norm.

"_4" superscript numbers following the series symbol in a complex map unit refer to the percentile of that series and phase in the map unit.

Examples:

Single Map Units:

SOU indicates the Souris series with minimal or absent phase features.

CRMp indicates the peaty phase of the Cromer series.

MNV/xxxs indicates the Martinville series, weakly saline phase; the erosion, slope and stoniness are minimal or normal for the series.

PPT1/xxxt indicates the Pipestone series, sandy substrate variant, moderately saline.

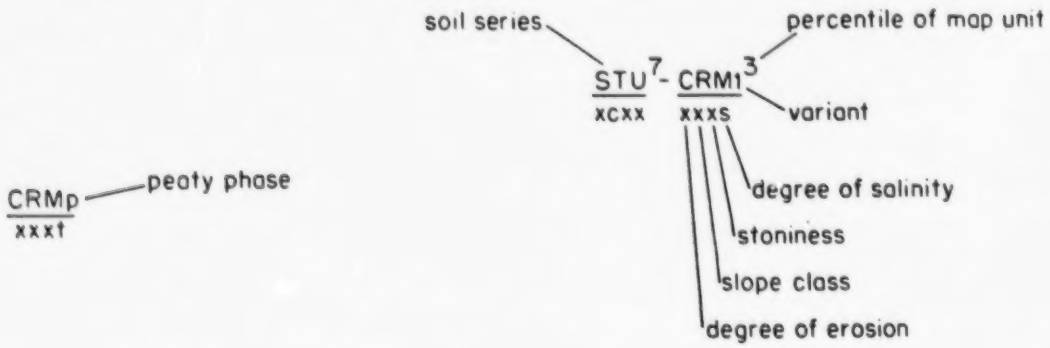
Complex Map Units:

STU$^{7}$/xcxx - CRM$_{1}^{3}$/xxxs indicates a compound map unit of:

70% Stanton series, moderately sloping 2-5%

30% Cromer series, sandy substrate variant, weakly saline.

## MAP UNIT SYMBOLOGY




| Degree of Erosion | |
|---|---|
| x | none to slightly |
| 1 | slightly eroded |
| 2 | moderately eroded |
| 3 | severely eroded |

| Stoniness | |
|---|---|
| x | stone free |
| 1 | slightly stony |
| 2 | moderately stony |
| 3 | very stony |
| 4 | exceedingly stony |
| 5 | excessively stony |

| Slope Class | | |
|---|---|---|
| x | 0-2% | level to gently sloping |
| c | 2-5% | gently sloping |
| d | 5-9% | moderately sloping |
| e | 9-15% | strongly sloping |
| f | 15-30% | steeply sloping |
| g | 30-60% | very steeply sloping |
| h | over 60% | extremely sloping |

| Degree of Salinity | | dS/m |
|---|---|---|
| x | nonsaline | 0-4 |
| s | weakly saline | 4-8 |
| t | moderately saline | 8-15 |
| u | strongly saline | >15 |

Soil Legend for PLUM LAKES Project

| Soil Symbol | Soil Name | Surface Texture | Soil Drainage | Mode of Deposition | Family Particle Size | Subgroup |
|---|---|---|---|---|---|---|
| CMR | Cameron | L | WELL | Lacustrine | Loamy | O.BL |
| CME | Cranmer | CL | IMPER | Lacustrine | Fine Loamy | GLR.BL |
| CRM | Cromer | C | POOR | Lacustrine | Clayey | R.HG |
| CRM1 | Cromer, Sandy Sub. | C | POOR | Lacustrine | Clayey/Sandy | R.HG |
| EBL | Emblem | L | POOR | Lacustrine | Loamy | R.HG |
| GDC | Grande-Clairiere | LS | WELL | Eolian | Sandy | O.R |
| HRY | Hartney | L | IMPER | Lacustrine | Loamy | CLR.BL |
| LYT | Lyleton | SL | WELL | Lacustrine | Coarse Loamy | O.BL |
| MHC | Marsh Complex | L | V.POOR | Variable | Textural Complex | R.G |
| MNV | Martinville | L | POOR | Lacustrine | Loamy/Sandy | R.HG |
| OKL | Oak Lake | LFS | POOR | Lacustrine | Sandy | R.HG |
| PPT | Pipestone | C | IMPER | Lacustrine | Clayey | GLR.BL |
| PPT1 | Pipestone,Sandy Sub. | C | IMPER | Lacustrine | Clayey/Sandy | GLR.BL |
| PAK | Plum Lake | SL | POOR | Lacustrine | Coarse Loamy | R.HG |
| RTO | Ralston | LS | IMPER | Eolian | Sandy | GLO.R |
| SCH | Scarth | FS | WELL | Lacustrine | Sandy | R.BL |
| SOU | Souris | LFS | IMPER | Lacustrine | Sandy | GLR.BL |
| STU | Stanton | LFS | WELL | Lacustrine | Sandy | O.BL |
| SWZ | Switzer | SL | IMPER | Lacustrine | Coarse Loamy | GLR.BL |
| WWS | Wawanesa | L | IMPER | Lacustrine | Loamy/Sandy | GLR.BL |
| ZZ | Water | | | | | |

MAPS
NOT
FILMED

CARTES
OMISES